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THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

PEDESTRIAN INDOOR NAVIGATION

"Nepal has learned the importance of geo spatial data"


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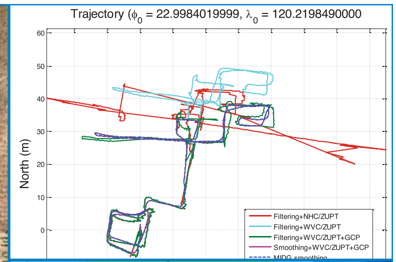

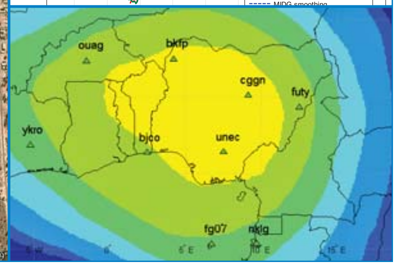

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Reducing risks

With over 9000 death and 23,000 injured

Nepal suffered hugely in

April earthquake and its aftershocks.

The country will take a long time to recover.

There were several initiatives undertaken…

Among which, the efforts of

The Survey Department and other agencies

For disaster risk reduction

Not only deserve attention and support

But also appreciation,

Given the constraints under which

They had and have to function (refer page 17).

Bal Krishna, Editor
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The future of the map – the map of the future

New and innovative technologies have an important impact into what cartographers are doing

Prof Dr Georg Gartner
Research Group Cartography, Department of Geodesy and Geoinformation, Vienna University of Technology, Vienna, Austria
Past President, International Cartographic Association

> A modern map is an interface that gives human users access to information stored in the map and beyond the map in databases. And if a modern map is such an interface, giving access to structured information, then the concept of modern cartography in one sentence would be 'efficient communication of geospatial information'

In the geospatial domains we can witness, that more spatial data than ever is produced currently. Numerous sensors of all kinds are available, measuring values, storing them in databases which are linked to other databases being embedded in whole spatial data infrastructures, following standards and accepted rules. We can witness also that we are not short of ever more new modern technologies for all parts of the spatial data handling processes, including data acquisition (e.g. UAVs currently), data modelling (e.g. service-oriented architectures, cloud computing), data visualisation and dissemination (e.g. Location-based Services, augmented-reality). So, **where are we now** with all those brave new developments?

Obviously **we are not short of data** in many ways. Clearly we can state, that it is rather the opposite. The problem is often not that we don't have enough data but rather too many. We need to make more and more efforts, to deal with all those data in an efficient sense, mining the relevant information and link and select the appropriate information for a particular scenario. This phenomenon is being described as "big data". Often application developments start there. Because we have access to data, we make something with them. We link them, we analyse them, we produce applications out of them. I call this a data-driven approach.

We are also **not short of technologies**. It is rather the opposite, while just being able to fully employ the potential of a particular data acquisition, modelling or dissemination technology new technologies come in and need to be considered. New technologies become available quicker and quicker and need to be evaluated, addressed and applied. Often application development starts there. Because we have a new technology available, we make something with it. I call this a technology-driven approach.

However, the particular need, demand, question or problem of a human user is often taken into account only when the data-driven or technology-driven application, product or system has been built. Often this causes problems or leads to products, systems and applications which are not accepted, not efficient or simply not usable. By starting from the question what are the demands, questions, problems or needs of human users in respect to location we could eventually apply data and technology in a sense, that they serve such **user-centred approaches** rather than determine the use.

But how can we unleash the big potential of geo information in such truly interdisciplinary approaches better? How can we make sure, that spatial data is really applicable for governments, for decision makers, for planners, for citizens through applications, products, systems which are not forcing them to adapt to the system but are easy-to-use and efficiently support the human user?

In this respect maps and cartography play a key role. Maps are most efficient in enabling human users to understand complex situations. Maps can be understood as tools to order information by their spatial context. **Maps can be seen as the perfect interface** between a human user and all those big data and thus enable human users to answer location-related questions, to support spatial behaviour, to enable spatial problem solving or simply to be able to become aware of space.

Today maps can be created and used by any individual stocked with just modest computing skills from virtually any location on Earth and for almost any purpose. In this new mapmaking paradigm users are often present at the location of interest and produce maps that address needs that arise instantaneously. Cartographic data may be digitally and wirelessly delivered in finalized form to the device in the hands of the user or he may derive the requested visualization from downloaded data in situ. Rapid advances in technologies have enabled this **revolution in map making** by the millions. One such prominent advance includes the possibility to derive maps very quickly immediately after the data has been acquired by accessing and disseminating maps through the internet. Real-time data handling and visualization are other significant developments as well as location-based services, mobile cartography, augmented reality.

While the above advances have enabled significant progress on the design and implementation of new ways of map production over the past decade, many **cartographic principles remain unchanged**; the most important one being that maps are an abstraction of reality. Visualization of selected information means that some features present in reality are depicted more prominently than others while many features might not even be depicted at all. Abstracting reality makes a map powerful, as it helps to understand and interpret very complex situations very efficiently.

Abstraction is essential

Disaster management can be used as an example to illustrate the importance and power of abstract cartographic depictions. In the recovery phase quick production of imagery of the affected area is required using depictions which allow the emergency teams to understand the situation on ground from a glance at the maps. Important on-going developments supporting the rescue work in the recovery phase are map derivation technologies, crowd sourcing and neo-cartography techniques and location-based services. The role of cartography in the protection phase of the disaster management cycle has always been crucial. In this phase risk maps are produced which enable governors, decision makers, experts and the general public alike to understand the kind and levels of risk present in the near and distant surroundings. Modern cartography enables the general public to participate in the modelling and visualizing of the risks their neighbourhood may suffer from on a voluntary basis. Modern cartography also helps to quickly disseminate crucial information.

In this sense cartography is most relevant. **Without maps we would be "spatially blind"**. Knowledge about spatial relations and location of objects are most important to learn about space, to act in space, to be aware of what is where and what is around us or simply to be able to make good decisions. Cartography is also most contemporary, as new and innovative technologies have an important impact into what cartographers are doing. Maps can be derived automatically from geodata acquisition methods such as laser scanning, remote sensing or sensor-networks. Smart models of geodata can be built allowing in-depth analysis of structures and patterns. A whole range of presentation forms are available nowadays, from maps on mobile phones all the way to geoinformation presented as Augmented Reality presentations.

Where are we heading to?

What we can expect in the near future is, that information is available anytime and anywhere. In its provision and delivery it is tailored to the user's context and needs. In this the context is a key selector for which and how information is provided. Cartographic Services will thus be wide spread and of daily-use in a truly ubiquitous manner. Persons would feel spatially blind without using their map-based services, which enable them to see who or what is near them, get supported and do searches based on the current location, collect data on site accurately and timely. Modern Cartography applications are already demonstrating their huge potential and change how we work, how we live and how we interact.

In that sense the role of the map has changed. Maps used to be artefacts, they had to look beautiful, well-designed, they had to store information for a long time because it needed to be used over a long period of time. In modern cartography there is an increasing number of functions to a map. Besides its old function of an artefact, a modern map is also an interface that gives human users access to information stored in the map and beyond the map in databases. The map has therefore the function of a table, structuring information through spatial attributes. And if a modern map is such an interface, giving access to structured information, then the concept of modern cartography in one sentence would be 'efficient communication of geospatial information'.

What is changing is then how maps are derived and produced. We can summarize the characteristics of modern maps as follows:

1. Real time: The world is permanently changing. To depict, communicate and display the world means to depict, communicate and display what is there right now, thus to find ways to shorten the time between data acquisition and data representation through maps. This is already true in real-time maps and rapid mapping approaches.
2. Ubiquitous: The accessibility and availability of maps need to be considered in an ubiquitous context, thus maps must be accessible and available anytime and anywhere.
3. Media-adequate: Maps are to be displayed and disseminated through various media. This can include paper, screens of all kind of formats, resolutions and sizes, or multimedia environments. This might also include in future smart watches, wearable devices, augmented reality devices etc. Whatever medium is used, the map needs to be tailored particular for this medium to fit its needs and constraints.
4. Personalized: Map are interfaces between geoinformation and human users, thus a mean of communication. From human communication we can learn, that we usually adapt what and now we communicate to our communication partner. Modern maps will do the same, thus being adaptive, reactive and anticipative on the context, the user and the use.
5. Well designed: Whatever map is used in whatever context on whatever medium for whatever reason there is a dogmatic attribute which has to be followed always when using maps: A map has to be readable! This simply means that is has to be visually perceivable. And this means that we need to avoid graphical conflicts. And we can do even more: we can not only make it readable but design it in a way, that it is pleasing to the eye, thus do more then conveying information.

The successful development of modern cartography as the discipline dealing with the development of such modern maps requires **integrated interdisciplinary approaches** from such domains as computer science, communication science, human-computer interaction, telecommunication sciences, cognitive sciences, law, economics, geospatial information management and cartography. It is those interdisciplinary approaches which make sure that we work towards **human-centred application developments** by applying innovative engineering methods and tools in a highly volatile technological framework. A number of important technology-driven trends have a major impact on what and how we create, access and use maps, creating previously unimaginable amounts of location-referenced information and thus put cartographic services in the centre of the focus of research and development.

To summarize

Modern Cartography is key to human mankind. Without maps we would be "spatially blind". Knowledge about spatial relations and location of objects are most important for enabling economic development, for managing and administering land, for handling disasters and crisis situations or simply to be able to make decision on a personal scale on where and how to go to a particular place.

New and innovative technologies have an important impact into what cartographers are doing. Maps can be derived automatically from geodata acquisition methods such as laser scanning, remote sensing or sensor-networks. Smart models of geodata can be built allowing in-depth analysis of structures and patterns. A whole range of presentation forms is available nowadays, from maps on mobile phones all the way to geoinformation presented as Augmented Reality presentations.

Maps and other cartographic products are attractive. Many people like to use maps, to play around with maps for instance in the Internet or simply want to look at them. We can witness a dramatic increase in the number of users and use of maps currently.

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Pedestrian Indoor Navigation with Smartphones

This study uses the indoor control point as the update measurement in the extended Kalman Filter (EKF) to aid the Inertial Navigation System (INS) without GNSS. The walking velocity from a pedometer and step length model is applied as the constraint of moving direction in EKF

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Personal navigation technologies have been evolving rapidly because of the increasing popularity of smartphones and portable devices in recent years. These devices have changed the developmental trend for indoor pedestrian navigation. However, some considerations restrict the cost, accuracy and practicality of related applications, especially in indoor environment without the support from Global Navigation Satellite System (GNSS).

This study uses the indoor control point as the update measurement in the extended Kalman Filter (EKF) to aid the Inertial Navigation System (INS) without GNSS. The walking velocity from a pedometer and step length model is applied as the constraint of moving direction in EKF. Moreover, the real-time smoothing is also implemented. The performances of proposed algorithms are verified with smartphones. The preliminary results show the improvement of the INS performance in real-time for pedestrian indoor navigation significantly.

Introduction

Smartphone is an ideal device as a mobile and positional pedestrian navigator because it can provide the basic information for navigation using internal sensors such as GNSS chip, inertial sensors, magnetometer, camera, Wi-Fi and Bluetooth. The other reason is the high popularity of such devices over the world. These characteristics can reduce the cost of businesses for pedestrian indoor navigation products and their promotion. Moreover, crowdsourcing for massive data such as of location and user's information facilitates the development of Location-based Services (LBS) and personal marketing.

Indoor pedestrian navigation technology has was being developed for nearly 20 years, and this has evolved in to numerous variants from its original form based on different theories and equipment [1-4]. The crucial issues are how to achieve the necessary accuracy without GNSS, as well as to overcome human motion.

The Pedestrian Dead Reckoning (PDR) estimates two-dimensional position by using a pedometer and heading sensor. The impact of gravity projection on horizontal components in INS is eliminated in PDR because of the non-integral calculation. However, the PDR cannot provide height information without a barometer, and its orientation accuracy is similar to INS that is restricted by the performance of a gyro or magnetometer. Furthermore, step length models generally use empirical formula which is incapable to perfectly fit individual characteristics. The step length can vary by as much as 40% among different pedestrians, even when they are walking at the same speed, and by up to 50% across the range of walking speeds of an individual [2].Tuning parameters or step length calibration can enhance the accuracy in post-processing but inconvenient for real-time application. In addition, the demonstration systems may have better performance than a production system because of the uncertainty of the coefficients [5]. Therefore, the PDR system is likely to require occasional position corrections from an external (absolute) positioning system to maintain stable performance [2],which is similar to INS.

Table 1: The characteristics of recently popular indoor positioning technologies

Currently common Indoor positioning technologies	WiFi	Bluetooth	RFID	Vision based	INS mechanization	PDR
Additional Infrastructures	Optional	Yes	Yes	Optional	No	No
Requirement of Database	Yes	Optional	Optional	Yes	No	No
Train process	Yes	Optional	Optional	Yes	No	Optional
Against environmental changes	No	No	No	No	Yes	Yes
Accumulated error with time	No	No	No	No	Yes	Yes

INS is usually integrated with the GNSS that utilizes the mechanization equations to estimate the position and orientation for seamless vehicle navigation in the GNSS-hostile environment. The pedestrian navigation error will rapidly drift because of the vibration and dynamic misalignment between body frame and pedestrian frame after the integration process, especially with the use of low-grade sensors. However, INS allows the change of environment and it doesn't require the database, training process and additional infrastructures. INS provides the continuously real three-dimension solution of position and altitude without the need of a barometer. Table 1 shows the characteristics and requirements of recently mainstream indoor positioning technologies. The additional infrastructures refer to the need of equipment such as wireless access point, transmitter and receiver.

Methodology

The integration of different methods would be a better solution with the higher cost-performance ratio for practical real-time applications. EKF is often used in multi-sensor fusion [6, 7]. The estimated state feedback to the INS mechanization after the measurement update compensates the errors, as well as replaces the previous state. Generally, the sensor errors are supposed to be determined in the laboratory [11]. However, these inertial sensors require the online calibration because of their low stabilities. The proposed system includes EKF, Walking Velocity Constraint (WVC), control point update and real-time smoothing as shown in Figure1. The GNSS measurement is only used for initial alignment. In general, the loosely couple is an ideal form to aiding in the INS mechanization by integrating the position or orientation, so the control points use the format of longitude, latitude, and height with available accuracy and the same coordinate system. The control points are surveyed by Total Station and broadcast by beacons.

The Non-holonomic Constraint (NHC) and Zero Velocity Update (ZUPT) are commonly used for INS/GNSS integrated systems for vehicle applications in the GNSS-hostile environment [8]. However, the smartphone is held in the hand, making it difficult to sense the stance phase of every stride rather than the shoe-mounted IMU in this study. Thus, the ZUPT was implemented when the user was standing on the control points. The NHC requires more stringent conditions for pedestrians because human motion has undesirable lateral and vertical movements as well as no constraint in moving direction. However, the integration of INS and PDR can improve the accuracy of INS pedestrian navigation, which was proposed in [5]. Thus, this study uses the walking velocity from a pedometer and step length model to constrain the velocity of moving direction in the EKF. The step length model used in this study is reference to [12], which considers more individual parameters.

The fix-interval smoother called Rauch-Tung-Striebel (RTS), was implemented in real-time by setting windows. The smoother estimates the optimal states by combining the forward and backward solutions of EKF [6]. The real-time smoothing for the INS/GNSS integration system and land-based vehicles was proposed in [9]. The concept used in this study is different from the reference which activated smoothing after filtering part of the data by setting windows rather than updating measurements at random are found. The major reason is that the error of pedestrian navigation will accumulate quickly without smoothing and the frequency of control point is not fixed like 1Hz of GNSS. Figure 2 illustrates the feasibility of real-time smoothing during the operation. The remaining time between filtering the k and k+1

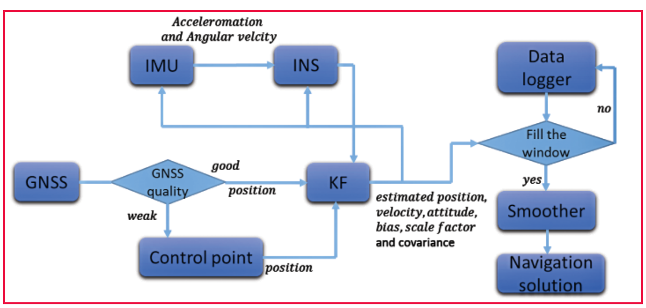


Figure 1: Proposed system with real-time smoothing and control point

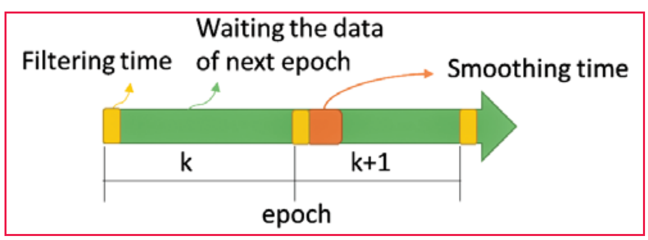


Figure 2: The feasibility ofreal-time smoothing

Figure 3: iPhone 5S and Samsung S5

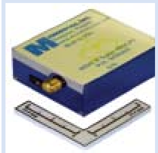
epoch is more sufficient to implement smoothing because the sampling rate of a smartphone for pedestrian navigation is usually set at 15~17 Hz.

Results and discussions

The iPhone 5S and Samsung S5 are used as the experimental smartphones, but they are separated into two scenarios as shown in Figure 3. The calibration reports of two smartphones can be referred to in the previous research [11]. The reference trajectories are provided by a commercial Micro Electro Mechanical Systems (MEMS) IMU MIDG-II and processed with the smoothing, NHC and ZUPT in post-processing. The specifications of this IMU are shown in Table 2. The experiments of smartphone and MIDG-II are conducted simultaneously on a common carrier to ensure that they capture the same trajectory and human motion. There are four control points chosen at special locations, such as the corner and the end of the corridor which update seven times during the experiments. In addition, the smartphone has inaccurate time label and sampling rate that cause a time synchronization problem between two sensors. So the analysis of orientation error cannot indicate the performance of the proposed system.

Figures 4 and 5 show the filtering trajectories of two smartphones with different constraint algorithms. The GCP signifies control point update in the following figures. Tables 3 and 4 show the numerical analyses of their positional errors. The results show that the WVC significantly improved positional accuracy of filtering solution in real-time. Furthermore, the control point fixes the trajectory at the correct location that reduces the remaining error to around 1 to 2 meters of RMSE. Smoothing with WVC/ZUPT and control point in post-processing provides the positional RMSE around 50 cm.

Table 2: Specifications of MIDG-II

	Specification				
		Bias		Scale factor error	
	Output rate (Hz)	Gyro (deg/hr)	Accelerometer (mg)	Gyro (ppm)	Accelerometer (ppm)
	50	4.7	6.0	5000	19700

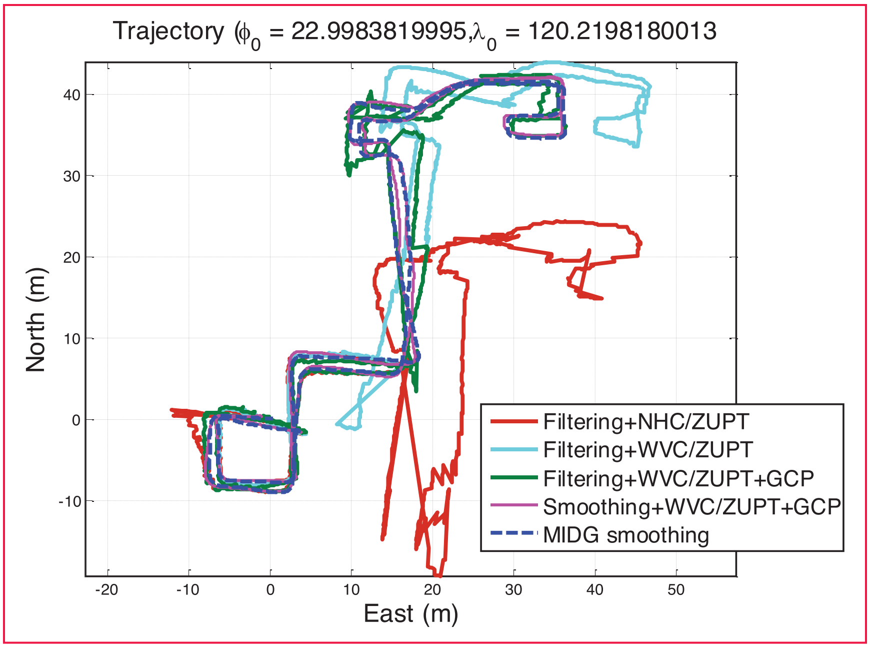


Figure 4: Trajectories of Samsung with different constraints

Table 3: Numerical analysis of positional errors for Samsung scenario

Samsung			
Maximum Error (m)			
	N	**E**	**H**
Filtering + NHC/ZUPT	42.4434	17.8689	9.1891
Filtering + WVC/ZUPT	8.2482	12.6542	8.1319
Filtering + WVC/ZUPT + GCP	5.2678	3.4510	4.2113
Smoothing + WVC/ZUPT + GCP	0.9934	1.5437	0.8396
RMS Error (m)			
	N	**E**	**H**
Filtering + NHC/ZUPT	14.8002	5.1419	3.6398
Filtering + WVC/ZUPT	1.9790	5.4046	3.7849
Filtering + WVC/ZUPT + GCP	1.2300	0.9918	0.8697
Smoothing + WVC/ZUPT + GCP	0.3470	0.3967	0.1928
STD of Error (m)			
	N	**E**	**H**
Filtering + NHC/ZUPT	10.8298	4.5642	2.8352
Filtering + WVC/ZUPT	1.9672	4.5010	2.6703
Filtering + WVC/ZUPT + GCP	1.2023	0.9531	0.6861
Smoothing + WVC/ZUPT + GCP	0.3471	0.3735	0.1917

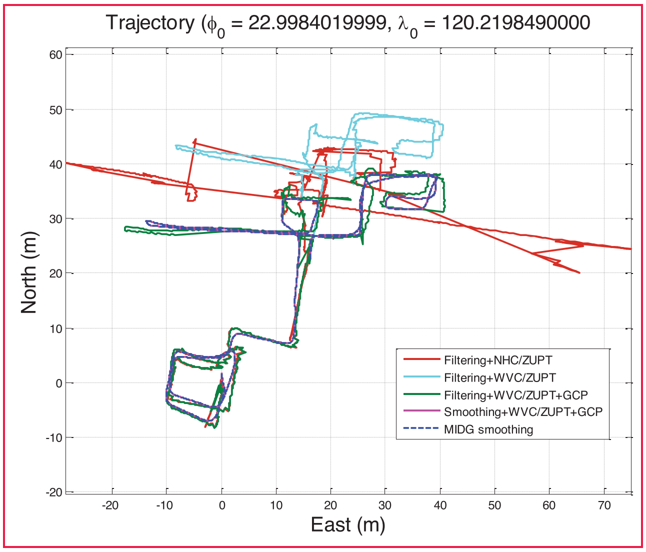


Figure 5: Trajectories of iPhone with different constraints

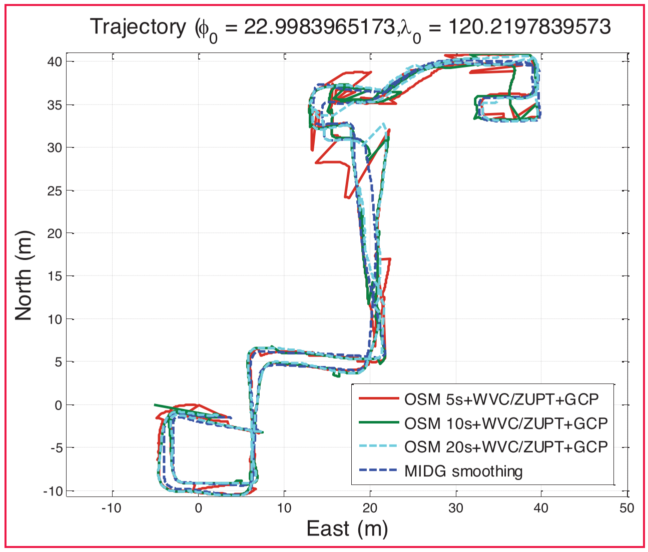


Figure 6: Real-time smoothing of Samsung scenario

Table 4: Numerical analysis of positional errors for iPhone scenario

IPHONE			
Maximum Error (m)			
	N	**E**	**H**
Filtering + NHC/ZUPT	18.0619	82.6971	6.8075
Filtering + WVC/ZUPT	15.2382	10.5535	4.2622
Filtering + WVC/ZUPT + GCP	3.6413	8.8276	4.2631
Smoothing + WVC/ZUPT + GCP	1.8793	2.8986	0.7766
RMS Error (m)			
	N	**E**	**H**
Filtering + NHC/ZUPT	4.6846	14.5990	3.4490
Filtering + WVC/ZUPT	8.9068	3.7412	1.1919
Filtering + WVC/ZUPT + GCP	0.9885	1.6341	0.9695
Smoothing + WVC/ZUPT + GCP	0.5507	0.5810	0.2295
STD of Error (m)			
	N	**E**	**H**
Filtering + NHC/ZUPT	3.8666	14.5965	2.9353
Filtering + WVC/ZUPT	5.8658	3.5451	1.1807
Filtering + WVC/ZUPT + GCP	0.9784	1.6314	0.9493
Smoothing + WVC/ZUPT + GCP	0.5480	0.5714	0.2037

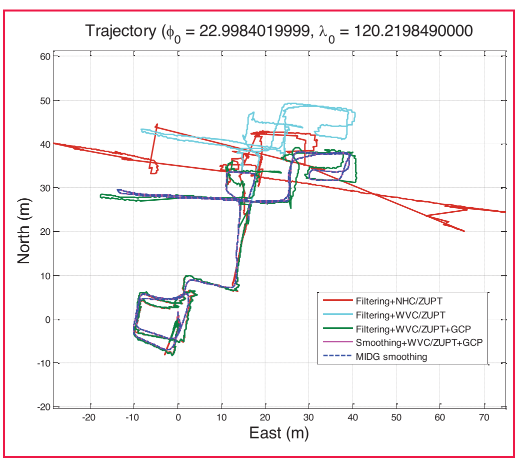


Figure 7: Real-time smoothing of iPhone scenario

Figures 6 and 7 show the real-time smoothing trajectories of Samsung S5 and iPhone 5S with different window sizes. All the trajectories are processed with WVC/ZUPT and control point. Tables 5 and 6 show the numerical analyses of positional errors. Improvement and stability increased when the window size became longer, such as 20 seconds. The highest improvement of real-time smoothing with 10s or 20s window provides the positional accuracy under the meter level. Figure 8 illustrates the relationship between the window size and positional error. The optimal window size means the smallest window size that can obtain the required accuracy for pedestrian indoor navigation. In addition, the update frequency of control point affects optimal window size because the basic concept of smoothing relates to the update measurement as well as the control point has higher effectiveness and reliability than constraint algorithms. The optimal window should be longer than 5 seconds but no longer than 20 seconds in this case, because the effectiveness of improvement decreases with time. For example, the difference of improvement between the window sizes of 10s and 20 seconds is less than that of the 5s and 10 seconds, respectively. The amount and distance of control point in this study almost make the implementation of the update in EKF at every 15s, which also implies the optimal window size. Thus, the optimal window size may be shorter when the frequency of measurement update is increased. Smoothing would be better to implement in near real-time mode when the control points are fewer.

Conclusions

The WVC and control point significantly improve the filtering solution in real-time. The performance of real-time smoothing is verified and depends on the frequency

Table 5: Positional error analysis of real-time smoothing of Samsung scenario

Samsung			
Maximum Error (m)			
WVC/ZUPT/GCP			
	N	E	H
Filtering	5.2678	3.4510	4.2113
Online 5 sec	5.9395	3.9361	3.2414
Online 10 sec	3.8347	3.3244	1.5016
Online 20 sec	4.9408	2.4800	1.4568
RMS Error (m)			
WVC/ZUPT/GCP			
	N	E	H
Filtering	1.2300	0.9918	0.8697
Online 5 sec	1.0854	0.9195	0.5467
Online 10 sec	0.6484	07452	0.3804
Online 20 sec	0.6913	0.6346	0.3586

Table 6: Positional error analysis of real-time smoothing of iPhone scenario

IPHONE			
Maximum Error (m)			
WVC/ZUPT/GCP			
	N	E	H
Filtering	3.6413	8.8276	4.2631
Online 5 sec	4.7680	8.8186	4.1972
Online 10 sec	4.2114	8.2043	3.1500
IPHONE			
RMS Error (m)			
WVC/ZUPT/GCP			
	N	E	H
Filtering	0.9885	1.6341	0.9695
Online 5 sec	1.0969	1.5530	0.8141
Online 10 sec	0.8574	1.2766	0.6265
Online 20 sec	0.6907	0.7679	0.4985

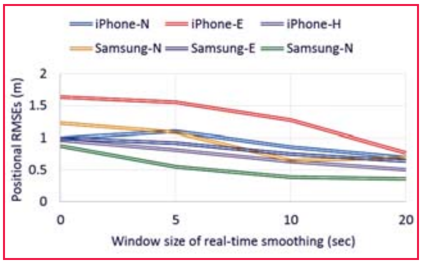


Figure 8: Relationship between the smoothing window size and positional accuracy

of update measurement to provide the best performance in real-time or near real-time. The control point used in the proposed architecture can be replaced by other positioning technologies with the precondition of available accuracy. This integrated architecture has better accuracy and stability by reducing the following: 1) the required amount of control points; 2) the optimal window size of real-time smoothing, and 3) the error of WVC cause by the inaccurate step length model and pedometer. Therefore, the INS can provide the required accuracy at meter or sub-meter level with the proposed algorithms for pedestrian indoor navigation in real-time.

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"Nepal has learned the importance of geo spatial data"

Says Ganesh Prasad Bhatta, Deputy Director General (Head: Cadastral Survey Division), Survey Department, Ministry of Land Reform and Management, Nepal in his interaction with Coordinates

Government of Nepal Briefly explain the mandate of Survey Department of Nepal?

Survey Department, under the Ministry of Land Reform and Management, is the National Mapping Organization (NMO) of Nepal. The Department is responsible for regulating, monitoring and coordinating mapping activities in the country.

Most of the national surveying and mapping activities such as geodetic surveying, topographic surveying, and cadastral surveying are under its mandate. Through cadastral survey, the Department is mandated to do the first registration of the land property. All the land records prepared by the Department are the foundation of land administration and management activities of the country. The Department is also mandated for international boundary surveys. Currently, the Department is working in the line to develop full functional national spatial data infrastructure (NSDI).

Furthermore, the Department is also mandated to issue license to the private surveyors, approve specifications for surveying and mapping activities undertaken by other agencies with public fund, provide permission for aerial photography in the country, maintain the quality of surveying and mapping activities carried out throughout the country, among others.

How does Disaster Risk Reduction (DRR) fit into your mandate?

Geospatial data are fundamental to respond any kind of disaster ranging from preparedness to rescue and post disaster reconstruction. Similarly, land records are equally important in order to assess the loss and restoration of land property affected by the disaster. Survey Department, being responsible for all kind of surveying and mapping activities at national level has produced all kinds of geo-spatial data including land records of whole country. Furthermore, Survey Department has the largest workforce in the country to work in the field of geo-spatial data or surveying and mapping, which the Government can mobilize at the time of need in order to response the disaster or its effect. On this basis, we can imagine how widely the DRR fits into the Department's mandate.

What has been the role and initiatives of Survey Department of Nepal?

Immediately after the devastating earthquake, Survey Department issued all the geo-spatial data of the disaster affected area free of charge through online. Some of the companies were so kind to provide the image data of pre- and post- disaster and the Department made use of it to produce damage assessment map, which was very useful for rescuing as well as assessing the loss. The Department provided necessary spatial information to the task force of the Government formed for the Post Disaster Needs Assessment (PDNA).

At the same time, the Department mobilized its staff, as instructed by the Government, to the disaster affected areas to assess the damage caused by the disaster. The Department feels proud to be a part of the Government's initiatives to assess the damage in a very short period of time.

As a scientific contribution, the Department carried out geodetic surveys soon after the devastating earthquake, using GNSS technology, in the affected areas and released the outcome of the study. The study found the shift of Kathmandu valley approximately 1.8 meters southwest wards. The study further made the Department to realize that the disaster has greatly affected the Geodetic Reference Frame of the country. Therefore, the Department has taken necessary steps to re-store the geodetic datum.

What are the key lessons learnt post Nepal earthquake of 2015?

There are several lessons we learnt from this disaster but I will concentrate mainly on the areas of the Department's mandate. We have realized that we need to have a higher level of awareness on the importance and availability of geo-spatial data and its type. The geo-spatial data needs to be updated frequently, there must be easy access to the data for everyone, the data sharing mechanism should be easy and user friendly, the involved organizations and human resources should have highest level of competency on GI technology, geo-data and its use.

What kind of applications of geospatial and GNSS technologies you visualize?

Information is power and location based information further adds value to it. As occurrence and effect of disaster is always location based, in my understanding, there can be numerous application of geospatial and GNSS technologies. We don't need to explain very hard core Geospatial and GNSS technology for this. Just look at the example of your mobile devices. Nowadays, most of the users have such devices and can acquire and share photographs in their surrounding and send to the relief and rescue personnel making use of social media. Google image is another such tool which is very helpful. Similarly application of open source platform are other easily accessible and low cost tool for sharing information during disaster. For serious disasters at some risky and inaccessible area application of low cost UAV and drone can be done.

What role do you see of Spatial Data Infrastructure in DRR?

If there is anything that plays important role in DRR is SDI. Without sufficient information, a good planning cannot be expected. A single entity cannot have all the data as required. Varieties of data are required to respond any disaster. What's the use of the data if its hold by many organizations but cannot make use at the time of need. Therefore, full functional SDI, with clear guidance of data sharing and accessibility, is essential to respond the disaster promptly.

Our organizational setup are quite traditional and capacity to work with modern technology is quite low. If we talk in context of modernization in geo-sector, we can say that our organizational setting is yet to get equipped with GI personnel and inbuilt GI technology

What is the current status of SDI in Nepal?

Current status of SDI is very primitive in Nepal. Survey Department has taken some initiatives for establishing SDI at national level through National Geographic Information Infrastructure Project since 2000. However, lots of things are yet to do to make it fully functional and bring all the geo-industries in the network. The NGII portal can be accessed at www.ngiip.gov.np. It has established all the digital database of the topographic base maps of the whole country.

Besides the initiatives from the Survey Department, there are some other government and non-governmental organization as well, which are generating spatial data for their specific purposes. For example, if we talk about different disasters, ICIMOD has been doing intensive research on glacial lake outbursts flood (GLOF) and established the database of occurred and may occurring GLOF. Similarly Department of Hydrology and Meteorology has detail information about the floods, and the Department of Mines and Geology has established some 29 GPS stations to monitor earthquake regularly. These are some of the examples and there are lot more. But unfortunately, all these information are isolated. So I prefer to say as I said earlier that the SDI in Nepal is in primitive stage.

What are the challenges in developing technology tools for DRR?

In my understanding, main challenges we, the geospatial professionals, are facing in developing technology tools for DRR are the capacity and policy issues. Our organizational setup are quite traditional and capacity to work with modern technology is quite low. If we talk in context of modernization in geo-sector, we can say that our organizational setting is yet to get equipped with GI personnel and inbuilt GI technology. The organizational capacity is yet to get the position of fully exploiting the potentials of recent graduates in the field of Geo-ICT. Many more has to be done to ensure the exposure of recent graduates with the advanced Geo-technology and its application in DRR. Lack of coordination among the various organization is another serious issue. In some cases, still there are gaps and overlaps in terms of jurisdiction and responsibilities among different organization of the government. Shortsightedness from the policy makers may result into the discontinuation of the Disaster response in long term. Research and Development issues in the field are rare due to the lack of long term commitment and financial support which limits the motivation of young GI professionals.

Do you think that there should be an interface between geospatial professionals and common man in terms of awareness and preparedness?

Of course, there should be an interface between geo-professionals and users. We as geo-professional, believe the involvement of common people will make our life easy in responding Disaster. In the recent time, various technologies have provided opportunity to enhance cooperation between geo-professional and common people. We can have several examples, one of the very common is the crowd sourcing. People with the help of their mobile devices can share very useful information among various social media. Open street mapping is another example. During Nepal earthquake, more than 5000 common people with the help of Google images and Open Street Mapping helped spreading very useful information for rescue and relief. These information shared by the people are processed by the professional at the situation room and supplied to the relief and rescue personnel which contribute saving hundreds of life. These kind of media and interaction will be very useful to raise awareness and enhanced preparedness.

Is Nepal better equipped now to face a similar situation in future?

It will be too early to say YES. But has Nepal learned the importance of geo spatial data and easy access to the data when required. Most important thing is the coordination among the institutions and their capacity to deal with such location based information. The recent disaster has opened the eyes of everyone including politicians, policy makers, bureaucrats, developers, and general people. Several steps have been initiated by the Government. Weakness and lacking have been identified. We need to have clear geo information policy regarding acquisition, maintenance, sharing and use. Integrated geo portal and SDI, Appropriate Geo-information technology, adequacy of human resources capable to deal with the technology, Government commitment and support including financial resources are basic and urgent needs to provide appropriate, accurate and timely information to respond such disaster. We really believe that we are going in right direction and will be capable to deal such kind of disaster in the days to come.

Geospatial Portal as an important SDI building block for Disaster Response and Recovery

International Centre for Integrated Mountain Development (ICIMOD) with its national and international partners has developed an Information Platform (Geospatial portal) to act as a unified information hub and and a single-gateway for validated data and information related to the earthquake

Biredra Bajracharya
Regional Programme Manager, MENRIS programme, International Centre for Integrated Mountain Development (ICIMOD), Nepal

Geospatial information systems provide the technology and tools to generate knowledge and added value in identifying problems and assessing alternative courses of action. Spatial data infrastructures (SDI) have evolved to address issues on coordinated development, access and use of geospatial information, and minimise resources wasted on duplication of efforts. The traditional view of mapping organisations being the sole producers and suppliers of geospatial information and users as passive recipients has changed with volunteered geospatial information where users also participate in information production.

Social media, crowdsourcing and mobile technologies have broken traditional barriers redefining how we work and share information from a local to global scale.

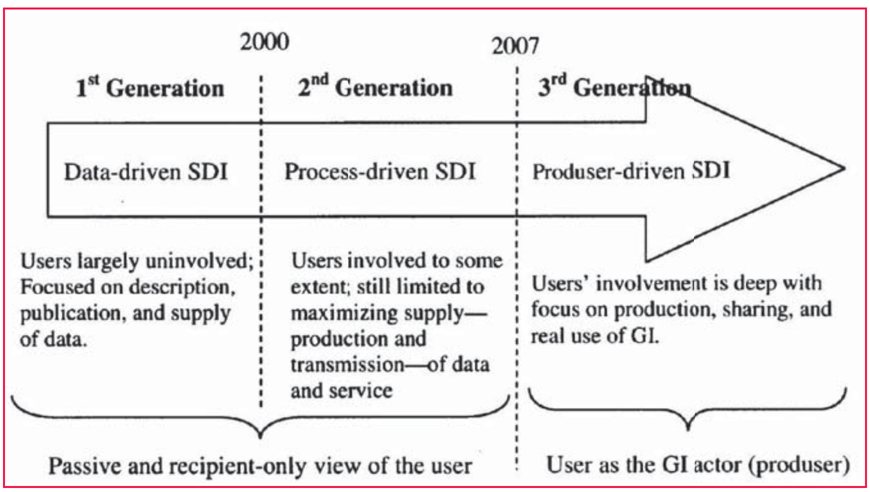

Figure 1: Evolution of SDI (Adapted from Rajabifard 2004 in Budhathoki et.al. 2008)

It has also created new opportunities for collaboration in the development of SDI.

These technologies played an important role during the recent Nepal earthquake with the death toll reaching nearly 9,000 and approximately 2.8 million people displaced. In a disaster of this scale, help and support were urgently needed. There was a tremendous surge in the demand for information. Information poured in from social media and crowd sources, within and outside the country on damage assessments from satellite images, landslide mapping, road blocks, and base maps of affected districts.

While such efforts contributed to the disaster response, in many ways, they also revealed many gaps and associated challenges. Collecting, managing, processing, and disseminating timely and reliable information is key to emergency management and a multitude of recovery and reconstruction operations. To address this need, ICIMOD with its national and international partners, developed an information platform (geospatial portal) to act as a a single-gateway for validated data and information related to the earthquake. As the country moves forward from relief to the reconstruction phase, ICIMOD is working on extending the platform to tailor information needs with various analytical features. A unified platform with geospatial tools will greatly support the efforts of reconstruction by enabling judicious planning and decision making with regard

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to resource allocation and mobilisation and will help foster coordination among various actors on the ground.

Geospatial Portal as an Important SDI Building Block for Disaster Response and Recovery

SDI and disaster

Every year, natural hazards such as floods and landslides cause loss of life, property and infrastructure in Nepal. Hundreds lose their homes and means of livelihood. In recent years, there has been an increase in the frequency and magnitude of these events in the region mostly attributed to the impacts of climate change (ESCAP 2015; Gurung et. al. 2014; Thomas et. al. 2013).

The 25 April 2015 Nepal earthquake and 12 May 2015 major aftershock brought a long-feared destruction in the country to reality. With a death toll reaching close to 9,000, another 23,000 injured, and more than 785,000 homes damaged or destroyed, about 2.8 million people were displaced. In a disaster of this scale, the need for urgent help is tremendous and the demand for information rises exponentially. Critical information is needed to support a multitude of response operations - search and rescue missions, relief distribution, construction of temporary shelters, recovery of human casualties, damage assessment, mobilisation of volunteers, and coordination with multiple organisations both within and outside the country. Location information is crucial for these actions and the role of geospatial information and technologies for disaster management is well recognised. Timely, up-to-date and accurate spatial information describing the situation is of utmost importance for successful emergency response (Bhanumurthy et. al. 2008; Mansourian et.al. 2005; Rajabifard et. al. 2004). Logistics are critical to the efficient allocation and dispatch of relief operations. However, the availability and access to reliable, accurate and up-to-date information are major challenges in such situations.

The concept of spatial data infrastructure (SDI) evolved in the early nineties to address a lack of coordination in the development, access and use of geospatial information, and to prevent resources being wasted in the duplication of efforts. SDI encompasses a framework of technology, policies, standards, and human resources required for acquiring, processing, storing, disseminating, and effectively utilising geospatial information (Nebert, 2004). Spatial data resources play an important role in disaster decision-making increasing efficiency, providing a better method for communication and collaboration among emergency forces (Snoeren et. al. 2007). The dynamic nature of an emergency situation calls for timely information from various organisations. No individual agency can produce and update all of the required information. This calls for partnerships, data sharing and data exchange. Therefore SDI and its components can play a major role facilitating emergency management by providing secure, fast, reliable access to spatial data needed by emergency response workers (Rajabifard et. al. 2004; Snoeren et. al. 2007).

Figure 2: Convergence of technologies

Evolutions in SDI

Development of SDI includes multiple actors, concerns, interests, points of view, and challenges. SDI has a dynamic nature due to the rate of technological advancement and changing user needs (Rajabifard et. al. 2006). The evolution of SDI has seen different approaches. In the product-based model, the main aim of an SDI initiative is to link existing and potential databases. In the process-based model, the emphasis is on facilitation through development of a knowledge sharing communication channel and capacity building. The composite product-process approach tries to balance the advantages drawn from both, enabling the SDI initiatives to be more versatile (Feeney et. al. 2001).

The traditional view of mapping organisations as the producers and suppliers of geospatial information and the users as the passive recipients of information is rapidly changing [figure 1] with the recent phenomenon of volunteered geographic information where the users also participate in information production (Budhathoki et.al. 2008).

The emerging technologies of social media, crowd sourcing, cloud computing and mobile devices and their convergence [figure 2] have broken the traditional barriers of organisations, professional domains and geographic borders. The increasing use of these technologies is redefining how we work and share information from a local to global scale and has opened new opportunities for collaboration in SDI development. SDI can be realised at different levels (local, national, regional, global) and involves an array of stakeholders both within and across organisations including different levels of government, private sector and a multitude of users.

Social media and crowd sourcing during disasters

The strengths of social networks for information gathering during disasters are real-time recording and a proactive user approach. The ability to capture, communicate an event, a problem or an opinion enables users to contribute in a collaborative way speeding up the problem solving processes (Capineri et.al. 2015).

The ubiquitous smartphone with GPS and camera has enabled citizens to collect real-time data on-location and monitor events important to emergency management. Mobile phones can be used effectively in collecting data for relief operations and damage assessment.

The developments of Open Street Map, Google Earth and a variety of other web-based mapping services has enabled volunteers to directly assist in disaster response situations through mapping and other spatial analysis. Distributed mapping makes it possible to produce large number of maps within a very short time which is one of the greatest benefits to disaster management and was demonstrated during the Haitian Earthquake (Zook et. al. 2010). Volunteered geographic information is gaining increasing relevance as a source of information complementing authoritative spatial data and contributes in SDI development in areas with poor GIS data coverage (Goodchild, 2007).

The Nepal earthquake experience

Global geospatial community coming together

The Nepal Earthquake of 25 April demonstrated how the advances in Information and Communication Technology (ICT) have made it possible for the global community to come together during the catastrophic events. Seven minutes after the event, a red alert for international assistance was issued by the Global Disaster Alert and Coordination System (GDACS). The first reference maps were also produced on the same day in order to facilitate response efforts. The\EU Copernicus Emergency Management Service\was also activated on the same day and provided the first reference maps the day after (JRC 2015).

The US Geological Survey (USGS)\compiled satellite imagery of the disaster area from different space agencies and made it accessible through its Hazard\Data Distribution System (HDDS). In terms of satellite imagery, DigitalGlobe\made the most significant contribution by making high resolution satellite imagery of the affected areas freely available online to all groups involved in the response effort. DigitalGlobe activated the subscription service FirstLook that provided emergency management and humanitarian workers with fast, web-based access to pre- and post-event images of the impacted area from its WorldView and GeoEye satellites (DigitalGlobe 2015). Many images were also made available by National Aeronautics and Space Administration\(NASA), Canadian Space Agency (CSA), Japan Aerospace Exploration Agency (JAXA), Planet Lab, ImageSat International and Skybox Imaging (UN-SPIDER 2015).

The compilation in UN-SPIDER Knowledge Portal (UN-SPIDER 2015) shows that many crowdsourcing communities became active to support mapping needs for relief work. DigitalGlobe activated Tomnod, a crowdsourcing platform that allowed web-connected volunteers around the globe to help disaster response teams by mapping damage from the earthquake. The\Tomnod website allowed users to participate in the Nepal campaign by tagging damaged buildings, roads, and areas of major destruction to inform disaster response teams on the ground. The Humanitarian Open Street Map Team (HOT OSM) mobilised 3679 mappers and made 62587 edits to the maps of the affected areas within five days of the earthquake. MicroMappers worked on analysis of images and text from tweets while MapAction worked on mapping of affected population. Humanity Road prepared situation reports including communities in need. Similarly United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA) implemented an information platform for the coordination of international humanitarian support and generated regular map products on the situation.

ICIMOD's response efforts

Immediately after the earthquake, ICIMOD formed a team of GIS and remote sensing experts. While a lot of satellite images were getting available from different space agencies through the international charter, extracting meaningful information and delivering them to the government and other agencies were challenging. Responding to the requests from the Ministry of Home Affairs (MoHA), the ICIMOD team supported by a group of volunteers worked round the clock to process and analyse the latest satellite imagery for mapping pockets of settlements in affected districts and creating profiles of affected VDCs to inform relief operations. A large number of maps were printed and supplied to different agencies. Another team from ICIMOD set up an office at the airport to provide information to helicopter pilots and dispatchers, including Google Earth 3D images of flight routes to help pilots navigate unfamiliar terrain, identify

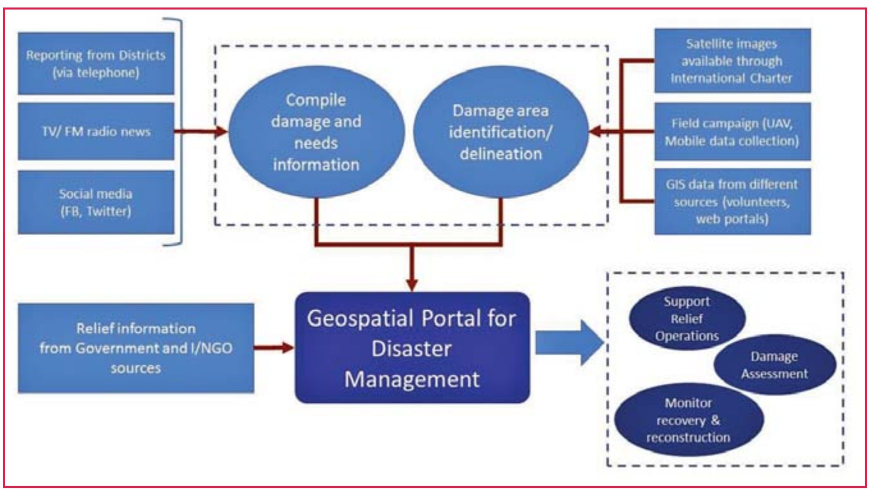

Figure 3: Framework for information synthesis and use

Figure 4: NDRRIP Portal

and recognise destinations, and plan appropriate landing spots (ICIMOD 2015).

Landslides were another major obstacle to rescue and relief operations and there was an urgent need to assess the impact of landslides for immediate rescue efforts and monitor potential hazards. ICIMOD formed a task force on geo-hazards for monitoring landslides, glacier lakes, and river courses by analysing the latest satellite images and communicating the findings to the Government of Nepal and relief agencies. The task force coordinated with a broad international team including Chinese Academy of Science, NASA, the University of Arizona, USGS, USAID and JAXA.

National Disaster Response and Recovery Platform (NDRRIP)

With numerous national and international agencies involved, it was felt that a comprehensive platform was needed where all information would be accessible and in a user-friendly interface. In collaboration with MoHA and technical support from Esri, ICIMOD deployed the Nepal Earthquake 2015: National Disaster Response and Recovery Information Platform (NDRRIP). The NDRRIP acts as a unified hub for earthquake-related information for use by government ministries and departments and other stakeholders engaged in disaster recovery and reconstruction. The framework of NDRRIP as a Geospatial Portal is illustrated in figure 3.

The portal provides key facts and figures at national, district, and VDC/municipality levels with interactive maps, charts, and infographics [figures 4 and 5]. Information is also provided under different thematic areas such as infrastructure, health, education, cultural heritage, agriculture, and geohazards. Story map journals for each affected district provide the status of casualties, damage, and response efforts. Other portal highlights are: an interactive before and after visualisations using high resolution satellite imagery; information on geohazards, including field data on landslides with 3D visualisation; and incident reporting for disaster events in near real-time through crowd sourcing.

Lessons for SDI

Challenges in generating useful information

Immediately after the event, there was a need for base maps to identify and locate affected areas and dispatch relief. Maps showing settlements and potential sites for helicopter landings were in high demand. The ICIMOD team was fully engaged compiling any available information from various sources including Google Earth. The gap on GIS base layers such as settlements, road networks, health facilities, open spaces and public utilities was seriously felt as they were either unavailable or were not up to date. Preparation of basic information layers needs to be given priority for disaster preparedness in future.

The availability of satellite images through on-line systems was unprecedented immediately after the Nepal earthquake. The international geospatial communities began preparing situation maps by using available imagery. Downloading large satellite images was impossible. The ICIMOD team worked with the NASA SERVIR Coordination Office in the US to reduce the size of images by tiling and resampling for file transfer. Many of the images were copied on hard drives and

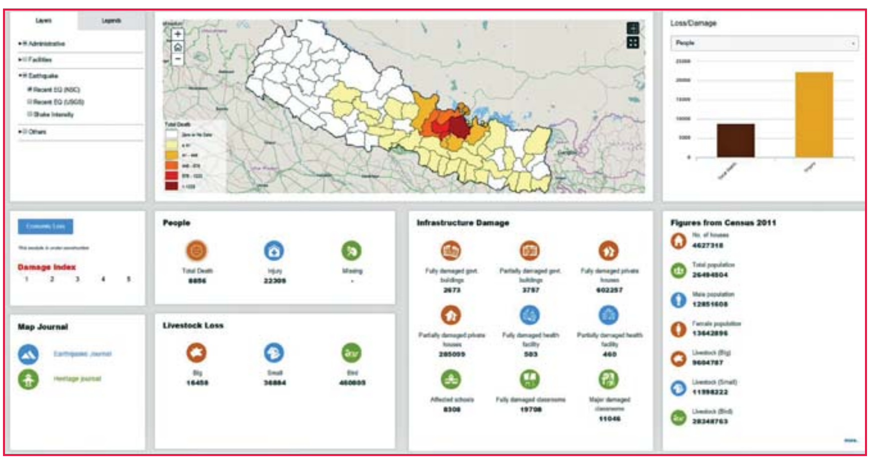

Figure 5: Interactive page for Country profile

physically delivered. Basic infrastructures such as electricity and internet play a vital role during disasters, a necessity requiring proper emergency back up in the event of an emergency. Moving towards cloud computing for hosting of data and services can be strategic to develop economically efficient systems (Díaz et. al. 2012) which are also resilient to such disaster events.

High resolution images were helpful for visualisation of the affected areas but extracting useful information from these images for use in a GIS platform was a big challenge. There were technical issues on geometric corrections and overlaying with other data layers. Maps showing damaged building assessments using satellite images were prepared by many agencies. However, the usefulness was a concern as the detection of damaged buildings accurately was not possible except for those completely collapsed. Development of algorithms for semi-automated damage assessment should be a topic of research interest in the field of image analysis and interpretation.

Satellite images were most useful in the assessment of geo-hazards which included mapping landslides and monitoring glacial lakes.

Consolidating information from the ground

The HOT OSM community's work in preparing the base maps of affected areas proved invaluable in generating value added products by other agencies. News on casualties and damages poured in from across the country. However, the information was aggregated at a district level and spatial details of damage were not available. Crowdsourced information on incidents and needs were limited to Kathmandu and were sporadic in nature. The trust and reliability of crowdsourced information has yet to be established for inclusion in government databases and response attention.

Many youth volunteers got organised to mobilise relief work and collect data on building and other damages. Various government departments and non-governmental organisations started campaigns for data collection from selected settlements and districts on their own, efforts that lacked any central coordination. The aspects of data storage, analysis and use seemed to be overlooked. Almost none of these campaigns considered geo-coding of data while collecting them. Knowing who is doing what and where is important for logistical purposes.

Delivering the information

In addition to gaps in information collection and generation, delivery of accurate information to the users in the correct format is important. Paper maps were still the preferred format by the users going into the field making printing facilities crucial. On the other hand, the very dynamic nature of information updates during such disaster makes on-line portals most suitable. ICIMOD's NDRRIP is one such effort to serve up-to-date information.

The Emergency Operation Centre of MoHA is the authoritative body for any disaster in the country. Current human resources and ICT infrastructure clearly need strengthening to deal with large disasters. Interaction with the IT team showed staff were overwhelmed with information requests as well as offers for assistance. Being the main hub for information flow from district offices, automated integration with the portal will make information dissemination more efficient. Without such a system in place, energy was spent digitising and storing data from many different sources and formats before serving on the NDRRIP.

Line agencies on utilities, roads, and health are producers and updaters of datasets everyday and during emergency situations (Rajabifard et. al. 2004). Adopting appropriate data standards and interoperability models by these agencies and data sharing will be a great support for disaster management. Geospatial portals can facilitate such inter-agency partnerships.

Moving towards reconstruction

As in any disaster event, attention from the international and national communities to the affected population slowly fades away with time and disaster management moves towards the phase of reconstruction. The information on damage and casualties become less dynamic and the demand for information slowly dies out. However, for reconstruction planning and management, more detailed information will be needed to deal with individual households. The issues related to relocation becomes even more complicated as it needs to consider economic, environmental and social aspects. Geospatial information becomes more relevant to analyse those different alternatives. Similarly, monitoring reconstruction activities and resources will be important in maintaining transparency of government interventions. The Geospatial Portal with appropriate geo-processing and query tools can fill this need to a great extent.

Conclusion

The 25 April Nepal earthquake resulted in a huge loss of life and was a major blow to the country's economy. There was an immediate humanitarian response from the international community including the International Charter which provided a large volume of satellite information assistance in producing map products (UN-SPIDER 2015). Extracting meaningful and effective information from these resources presented challenges due to technical infrastructure limitations. There was a need for better field data coordination, collection and application. Crowdsourcing has the potential to fill the gaps in spatial data and real time event reporting. There is a growing mass of young volunteers who can contribute to SDI in a collaborative way. Partnerships among all line agencies adopting interoperable data models are needed for best scenario disaster preparedness. This requires implementation of a functional SDI. The costs and benefits associated with SDI development is not clear (Masser 2015), however, the social benefits in assisting efficient emergency management will go way beyond economic benefits. Geospatial portals form essential components of SDI implementation by providing collaboration platforms for data sharing and access. The participation of multiple agencies will promote data quality and an adoption of standards. The NDRRIP was developed by ICIMOD to fill the gap of such a platform and to support earthquake response and recovery efforts. As the country recovers, ICIMOD is working on working on extending the platform to tailor information needs with various analytical features. It is hoped that such a unified platform with geospatial tools will improve reconstruction efforts by enabling judicious planning and decision making on resource allocation and mobilisation and will help foster coordination among various responders on the ground.

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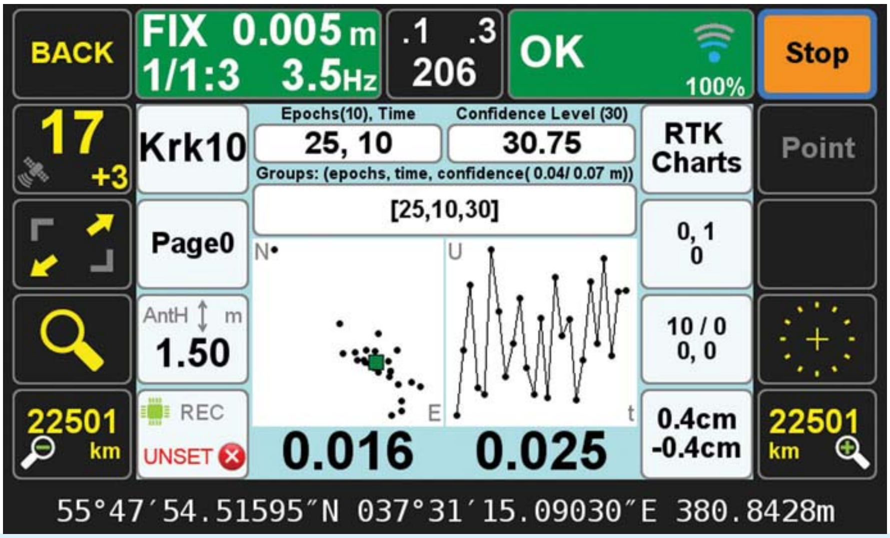
Monitor and record the health of your shots

Verify, Monitor, Record, Present and Defend

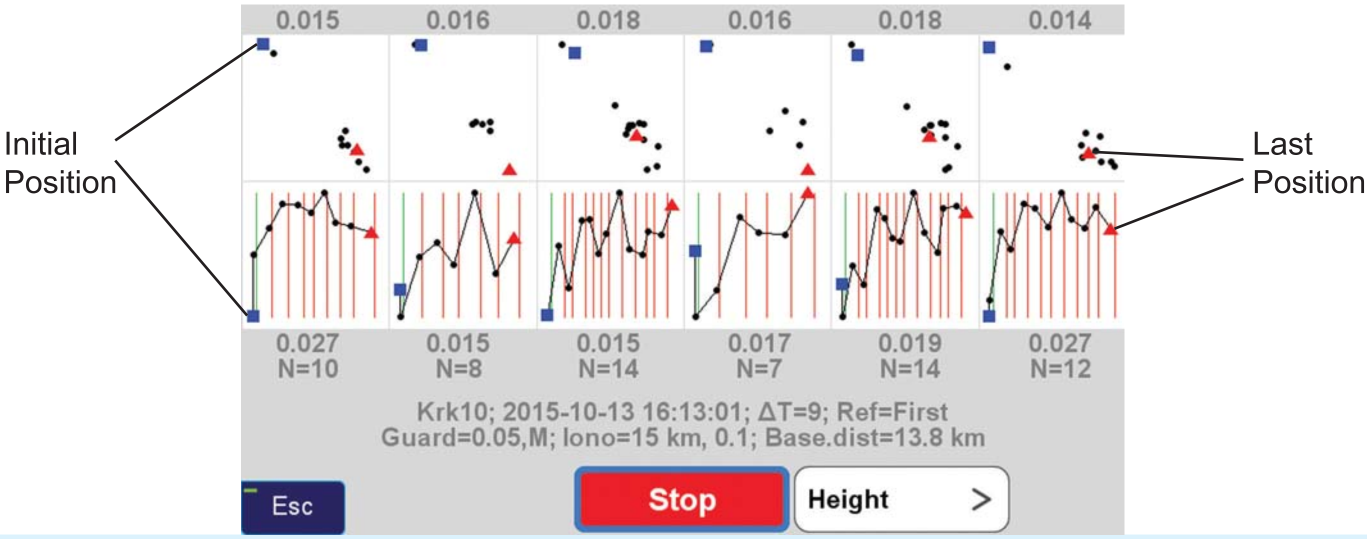
RTK is a statistical process by nature and needs **verification**. TRIUMPH-LS has **six different RTK engines** and extensive automatic verification to ensure your shots are 100% reliable (see the article inside).

It also has many tools to **document** the process of your shots for **presentation** when you need to **prove** and **defend**. The screen shots on following pages can automatically be recorded and attached to each point and easily **exported in HTML format**.

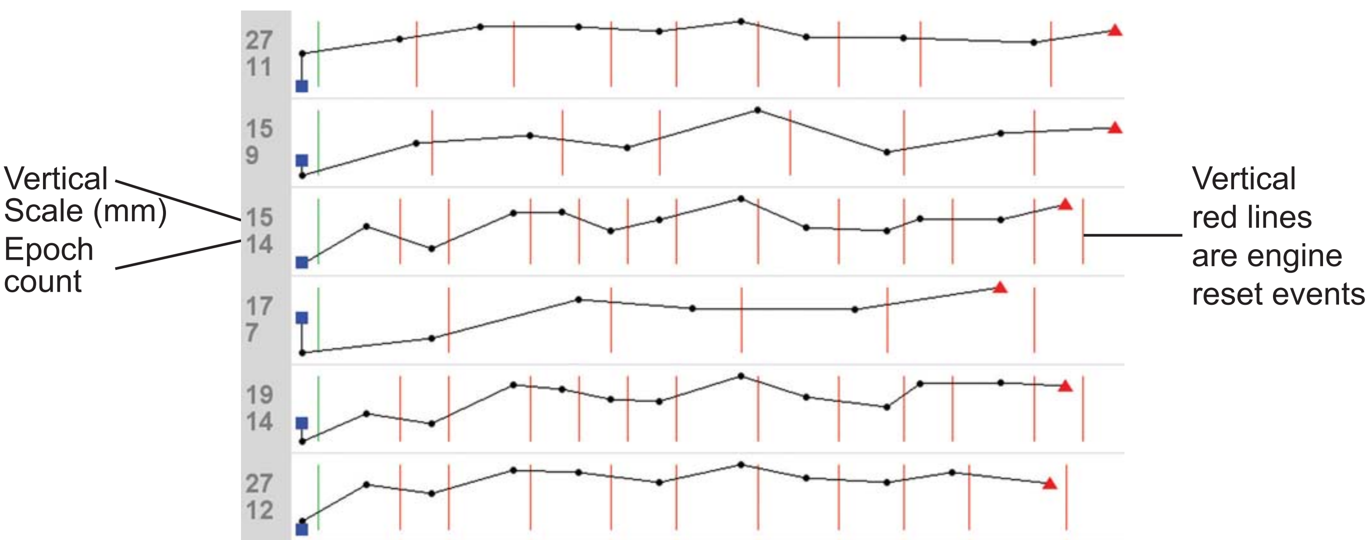
Continue next page



Phase-1 Action screen



Phase-1 Horizontal and Vertical plot of each of the six engines



Phase-1 expanded vertical plot of each of the six engines

Concepts Behind RTK Verification

Fundamental in the determination of GNSS solutions is calculating the correct number of full wavelengths (so-called ***fixing ambiguities***) in order to figure out the distances from the satellites to the receiver. In doing Real Time Kinematic (RTK) surveying, we need it fast and we need it to be correct.

Multipath, the reflections of GNSS signals from ground and nearby objects and structures create their own indirect measurements from the satellites to the GNSS receiver. It's as if your measuring tape is bent around an obstacle such as a tree instead of a free and clear line of sight between two points. No calculator is going to improve this result.

TRIUMPH-LS has sophisticated hardware to distinguish between the direct and indirect signals and remove most of the indirect signals. It also reports the amount of indirect signal that has been removed. The worst case is when the receiver doesn't see the direct signal at all; e.g., the satellite is behind a building, but it's still receiving the signal reflected off of the nearby structure. It is the task of the RTK engines to isolate such indirect signals and then exclude them from the calculations.

If too many of the signals are affected by severe multipath or indirect signals, no solution may be found. Remember, indirect signals are analogous to the bent measuring tape! When you're preforming RTK surveying, observe your environment and come to recognize that the structures around you are like mirrors for GNSS signals.

The other aspect impacting the veracity of a fixed solution is when there are weak GNSS signals. Frequently, weak signals are due to their penetration directly through tree canopy.

While **TRIUMPH-LS** can't move the obstacles that are creating multipath out of the way, its sophisticated hardware has advanced multipath reduction sub-system, its tracking software is designed to handle even the weakest signals, and its **J-Field** software provides reliable RTK solutions like no other system with its **Automatic RTK Verification System** (patent pending). J-Filed also has ample tools to demonstrate the reliability of the solution or warn against questionable results. You can readily see that without such tools other systems can provide you wrong and misleading solutions.

J-Field uses six RTK engines (Figure 1) running in parallel plus a support engine to monitor and aid the six engines. Each engine uses a different criteria and mathematical method tailored to resolve ambiguities in different conditions. These six parallel engines not only verify robust solutions but also maximize the possibility of providing solutions in all conditions.

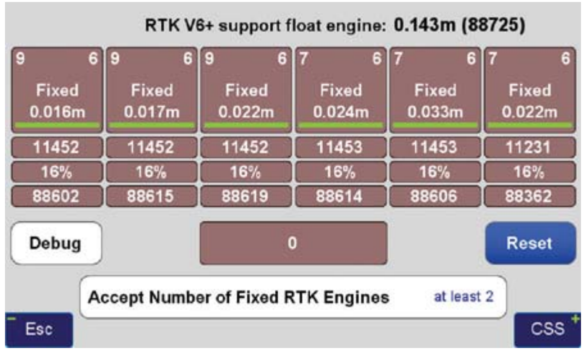


Figure 1 *V6+ six RTK Engines*

User Defined Verification Tools

J-Field provides the option for you to specify the **Minimum Number of Fixed RTK Engines** in verifying solutions **N** times before a position is automatically accepted where **N** is a user defined value.

J-Field employs two metrics to evaluate the performance of its RTK system of six engines: **1) Confidence Counter, and 2) Consistency Counter.** (Figure 2)

Confidence Counter

Figure 2 *Verify Settings*

This metric is incremented each time an engine is reset, ambiguities are recalculated, and the solution is in agreement with the previous ones (as defined by the **Confidence Guard (CG)**, default value 5 cm) is achieved. The Confidence Counter increments by 1, 1.25, 1.5, 1.75, 2.0, and 2.5 depending on the number of reset engines that fix in that epoch.

Consistency Counter

The Consistency Counter is incremented each time a solution is in agreement with the previous ones (as defined by the Confidence Guard) irrespective of engines being reset or not. The Consistency Counter is incremented by 0.0, 0.1, 0.25, 0.5, 1.0 and 1.5 depending on the number of fixed engines used in that epoch. Note that one fixed engine gets no credit and 6 fixed engines gets a **Consistency Credit** of 1.5.

Using these Confidence and Consistency verification tools, J-Field has two options to achieve reliable RTK solutions: **1) Verify With Automatic RTK Engines Resets** and **2) Verify Without Automatic RTK Engines Resets.**

Verify with Automatic RTK Engines Resets

This method has two steps: **1) Confidence Building** and **2) Smoothing and verifying**.

• **Step One**

In Step One, fixed engines are reset and solutions are collected into groups. Each group contains all the epochs located within a specified radius (the CG value) from its center and new groups are created as necessary so that all epochs fall into at least one group. Each group has its own Epoch Counter, Confidence Level and Elapsed Time. A point may fall into more than one group. The current best group is shown within [ ] and others within ( ). Step One continues until a group reaches the Confidence Level. (Figure 3)

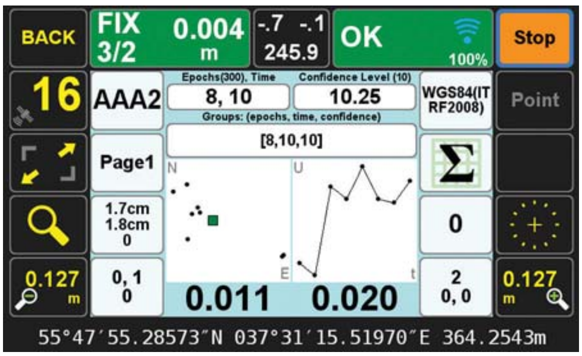


Figure 3 *End of Step one*

• **Step Two**

In Step Two, engines are not reset and solutions which are inside the CG of the selected group are added to that group for the remaining number of epochs that user has requested (Epoch Number, EN). Solutions that are outside the CG of the selected group, will be ignored but counted and on each such epoch, the RTK engines will reset. If the number of ignored points reaches 30% of EN, the whole process will restart. J-Field has 6 parallel RTK engines. You can specify the minimum number of engines required to be fixed to provide an epoch solution in Step Two. If the number of groups exceeds the Max Group the process restarts at Step One. This is to reduce the possibility of creating too many groups and rare false solutions in difficult environments. (Figure 4)

In both steps the Consistency Counter is also incremented as mentioned earlier.

You can manually reset all RTK engines via the V6-RTK engines screen (Figure 1), or assign this reset function to any one of the U1 to U4 hardware

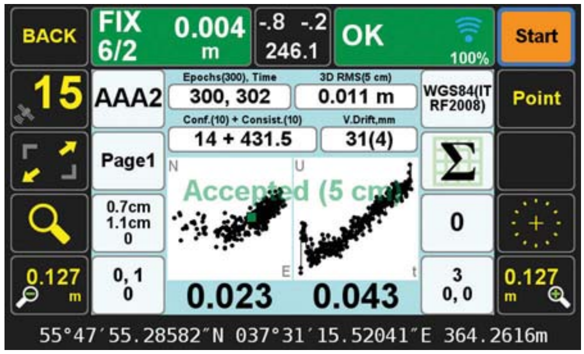


Figure 4 *End of Step 2*

buttons in front of the TRIUMPH-LS for easy access.

Verify without Automatic RTK Engines Resets:

In this method we don't force the RTK engines to reset but rely mostly on the Consistency Counter. There will be only one group as selected by the first epoch. Solutions that are not within the Guard band of the current average will be thrown out. If more than 30% of solutions are thrown out, the process will restart.

The horizontal and vertical graphs presented in both approaches also help the surveyor to evaluate the final solution. The linear drift of the vertical solution and its drift RMS are also shown above the vertical graph. A high linear drift (more than few centimeters) reveals severe multipath or, in rare cases, a wrong ambiguity fix. Pay close attention to the vertical drift and the horizontal and vertical scatter plots of epochs. Consider the scatter plots as doctors examine X-rays to determine anomalies.

The desired **Confidence Level** and **Consistency Level** are user selectable. Default values are 10. These parameters along with the desired number of epochs must be reached before a solution is provided.

In either case there is also a **Validate** option which, when selected, will reset all engines at the end of the collection and continues with 10 more epochs to validate if the solution is within the desired boundary of the Confidence Guard. (Figure 2) Minimum number of engines for the Validation Phase is user selectable.

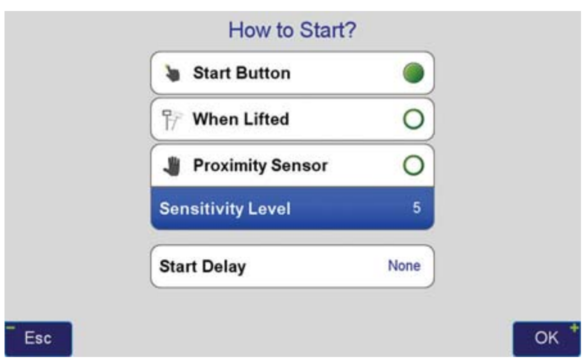


Figure 5 *How to Start*

Figure 6 *How to Stop*

In either case, if Auto-Accept is activated, the position will be automatically accepted if the RMS of the final solution is less than what user has selected in the Auto-Accept screen. (Figure 6)

You can also use **Auto-Restart** if you want to monitor structures or test the RTK system unattended. (Figure 6)

Screen Shots of Action Screen

Action Screen shows detailed information about each point collected. Screen shots can automatically be attached to each point and saved at the end of each collection (Figure 7). In **Verify with Automatic RTK Engines Resets** screen shots at the end of both Step One and Step Two are saved (Figures 3

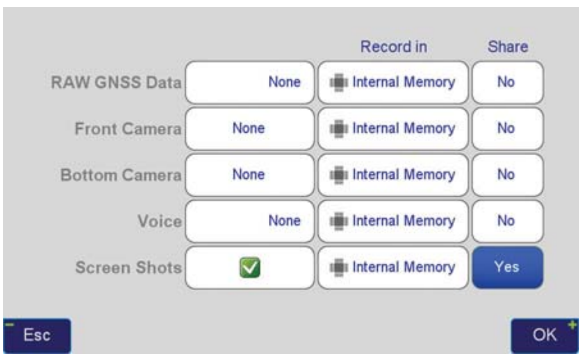


Figure 7 *What to record screen*

and 4). In Action screen there are 8 white boxes that selected items can be viewed on them.

Review Screen

View cluster of all points. Select the desired point to see its point cluster (Figure 8). Click the icons to see additional details about that point (Figure 9) including the distance and direction to the current point (Figure 10).

The effects of multipath, ionosphere, orbit, and other sources of problems somewhat exponentially increase as the baseline length increases. In a VRS/RTN scheme your **actual** baseline length is the actual distance to the nearest base station. The **virtual** base station that is mathematically created is not the actual length. We strongly recommend using your own base station near your job site in a

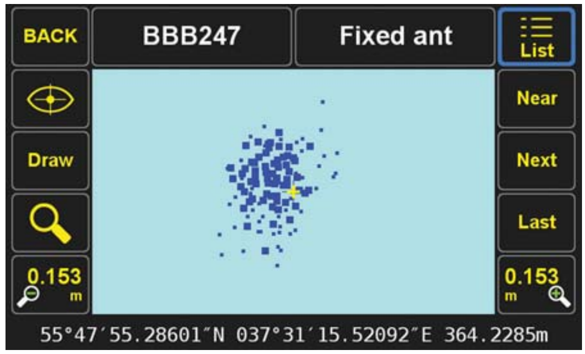


Figure 8 *Review screen shows cluster of 386 points*

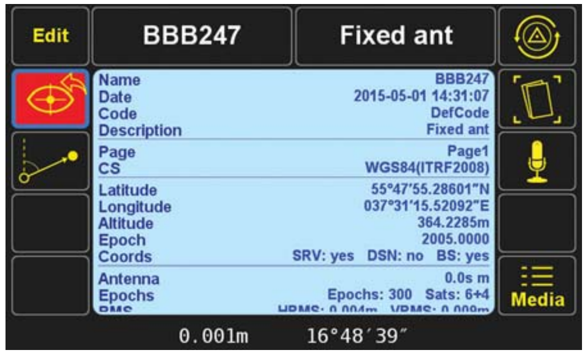


Figure 9 *Detailed information on selected point (scroll to see all information)*

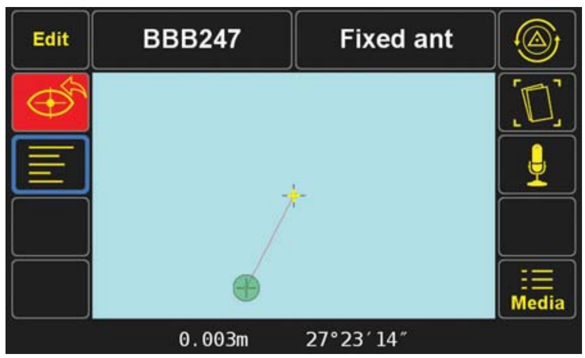


Figure 10 *Distance and direction from the current point to the selected point*

Verified-Base RTK (VB-RTK) scheme.

In addition to providing you with the most reliable RTK solutions (especially true in remote areas where cell coverage is hit or miss), using your own base receiver allows you to easily tie your solutions to well-established IGS/NGS spatial reference systems through Javad's exclusive Data Processing Online Service (DPOS) and J-Field's user-friendly Base/Rover Setup. Note that post-processed results returned to the Triumph-LS using DPOS are dependent on the availability of orbital data from NGS and may require several hours. For further reading about DPOS, its integration into J-Field and the streamlined approach developed by Javad for setting up the base and rover, please check out Shawn Billings' excellent article on VB-RTK on our website. Point your browser to: *http://www.javad.com/jgnss/javad/news/pr20150219.html*

Alternatively, if you don't have access to IGS-type stations to use DPOS, you can select an open area near your job site and use TRIUMPH-LS to obtain its position via RTN networks for about 5 minutes. You may repeat a couple of times for assurance. Then transfer this position to the TRIUMPH-1 or TRIUMPH-2 to use as the base station near your job site. The Base-Rover setup screen in the TRIUMPH-LS makes this job very easy.

Instantaneous Multipath charts

TRIUMPH-LS removes most of the multipath instantly on every epoch. Click on the Satellite icon to see the Signal Strength of satellites and then click the "+" key to see the multipath charts.

Figure 11 shows the amount of code phase multipath that TRIUMPH-LS has removed; relative to a fixed level. That is why negative numbers are in this figure. Units are in centimeter. Noting the signs in this figure, the amount of multipath in some satellites is in excess of 5.6 meters.

Figure 12 shows the amount of carrier phase multipath that TRIUMPH-LS has removed relative to a fixed level. Units are in millimeter. Noting the signs in this figure, the amount of multipath in some satellites is in excess of 4 centimeters.

SAT	EL	L1	P1	P2	L2C	L5
GPS2	29↑	273	281	-76	--	--
GPS6	44↑	55	201	-60	-5	189
GPS12	70↑	183	190	-90	-94	--
GPS14	25ˉ	281	317	-97	--	--
GPS17	23↓	332	364	-74	6	--
GPS24	53↓	117	566	67	-64	124
GPS25	30↑	243	218	-42	-50	-34
GLN1	10↑	305	229	-126	-404	--
GLN8	16↓	26	87	-484	-617	--
GLN9	32↑	359	301	-246	55	--
GLN15	31↓	276	203	-93	-2	--
GLN16	84↑	235	309	-133	-109	--
GLN17	39↓	52	-84	-156	-52	--
GLN18	69↑	190	168	-177	-184	--
GAL12	68ˉ	680	-121	246	--	32
SB127	25ˉ	469	--	--	--	319
SB128	15ˉ	206	--	--	--	322
QZ193	13↑	550	513	--	56	55
BDU2	16ˉ	299	--	--	--	275
BDU5	25ˉ	269	--	--	--	230
BDU8	25↓	145	--	--	--	143

SAT	EL	L1	P1	P2	L2C	L5
BDU11	75↑	362	--	--	--	305
BDU12	36↓	288	--	--	--	200
GPS3	10	--	--	--	--	--
GPS29	3	--	--	--	--	--
GPS32	3	--	--	--	--	--
GLN7	3	--	--	--	--	--
GLN19	12	--	--	--	--	--

Figure 11 *Code Phase multipath removed (cm)*

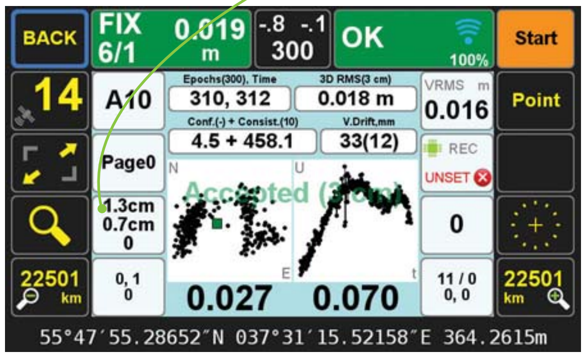
SAT	EL	AZ	L1	P1	P2	L2C	L5
GPS2	29↑	154	7	7	2	--	--
GPS6	44↑	98	11	9	2	2	-13
GPS12	70↑	282	7	8	-2	-2	--
GPS14	25ˉ	302	5	8	-4	--	--
GPS17	23↓	58	6	9	-6	-2	--
GPS24	53↓	196	1	4	13	1	-12
GPS25	30↑	282	4	8	7	1	-32
GLN1	10↑	34	1	4	-15	-23	--
GLN8	16↓	344	12	15	17	25	--
GLN9	32↑	316	0	2	-3	-6	--
GLN15	31↓	142	5	5	0	1	--
GLN16	84↑	266	2	2	-11	-18	--
GLN17	39↓	44	-1	-4	-12	-10	--
GLN18	69↑	188	-1	3	-1	-6	--
GAL12	68ˉ	108	0	-26	0	--	-14
SB127	25ˉ	160	7	--	--	--	-4
SB128	15ˉ	130	9	--	--	--	-11
QZ193	13↑	68	-3	-1	--	1	-19
BDU2	16ˉ	132	-7	--	--	--	-17
BDU5	25ˉ	154	-4	--	--	--	-7
BDU8	25↓	54	-10	--	--	--	-20

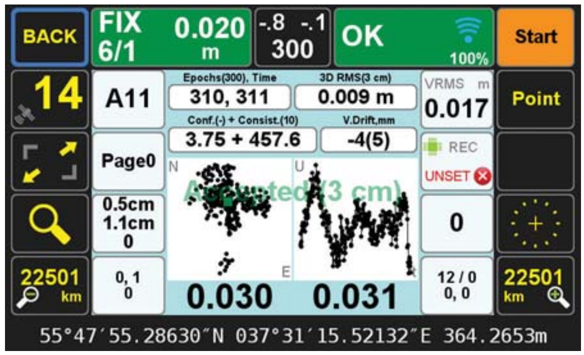
SAT	EL	AZ	L1	P1	P2	L2C	L5
BDU11	75↑	158	-6	--	--	--	-5
BDU12	36↓	60	-6	--	--	--	-14
GPS3	10	26	--	--	--	--	--
GPS29	3	229	--	--	--	--	--
GPS32	3	346	--	--	--	--	--
GLN7	3	297	--	--	--	--	--
GLN19	12	210	--	--	--	--	--

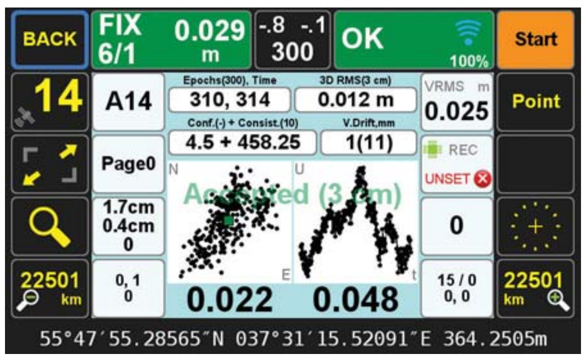
Figure 12 *Carrier Phase multipath remove (mm)*

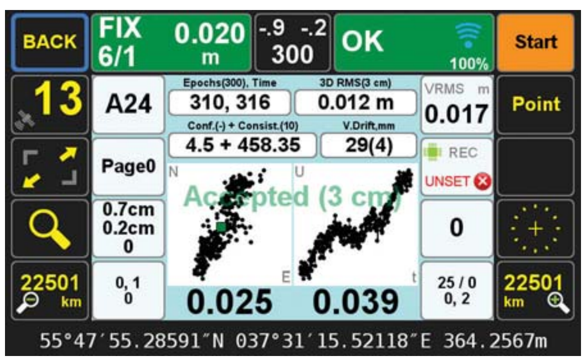
Multipath Showcase

Graphs in the following examples show multipath effects in a 13.8 km baseline where about 1/3 of the rover sky was blocked by a tall building. This box shows horizontal (top) and vertical (bottom) offsets from the actual coordinates of the point (earlier surveyed for test).

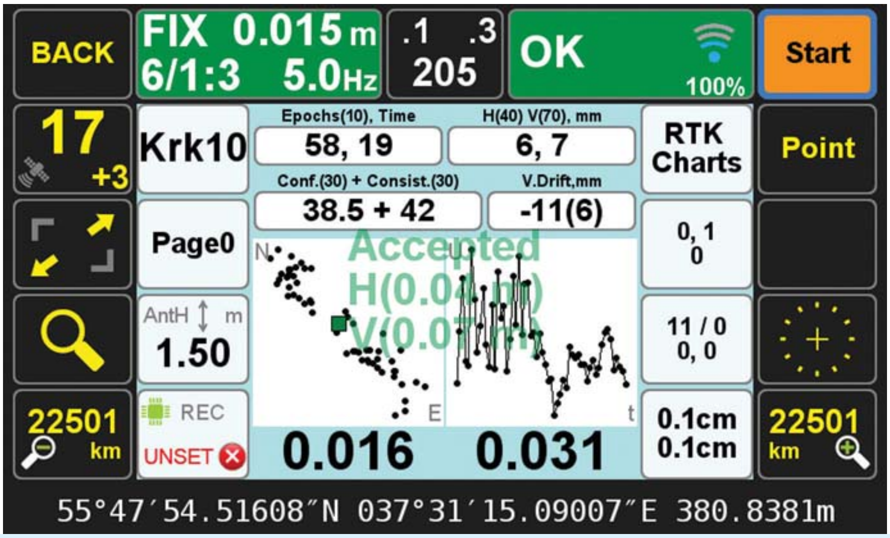




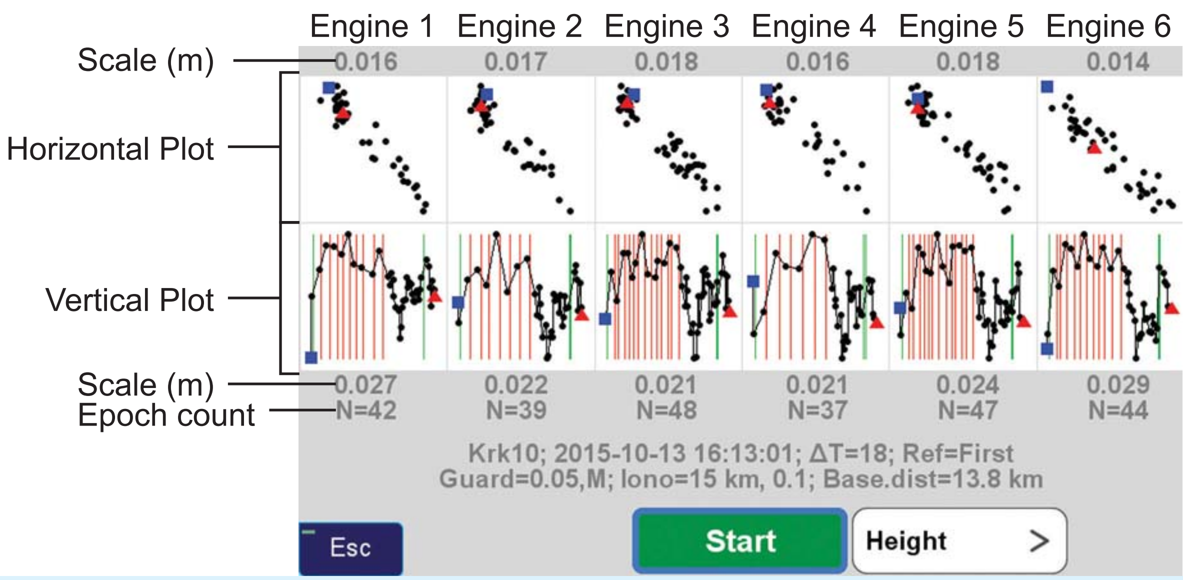




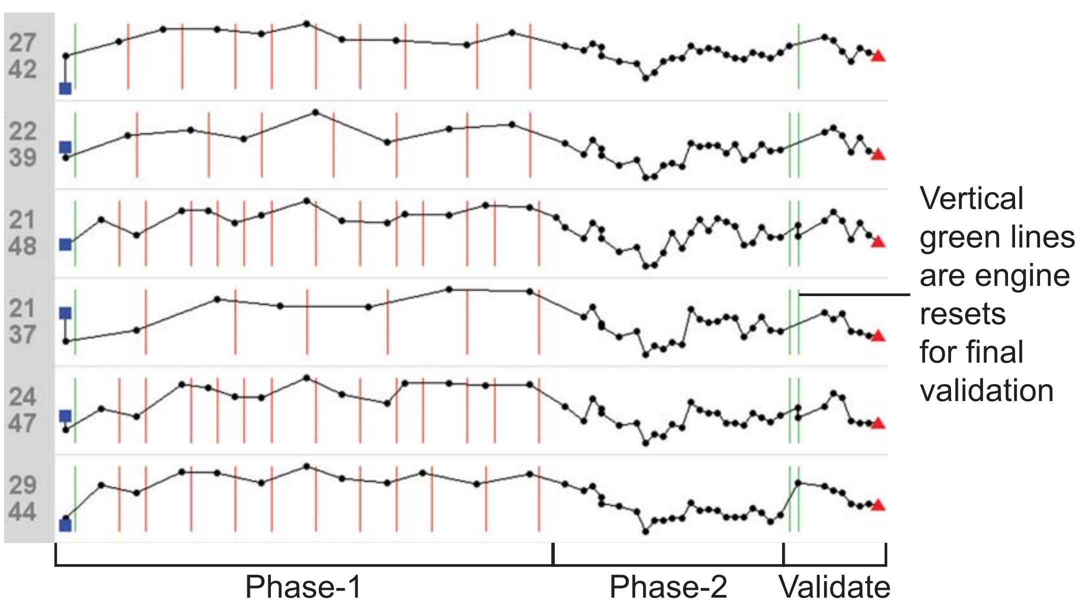
Javad Ashjaee, Ph.D.



Phase-2 Action screen



Phase-1 & 2 Horizontal and Vertical plot of each of the six engines

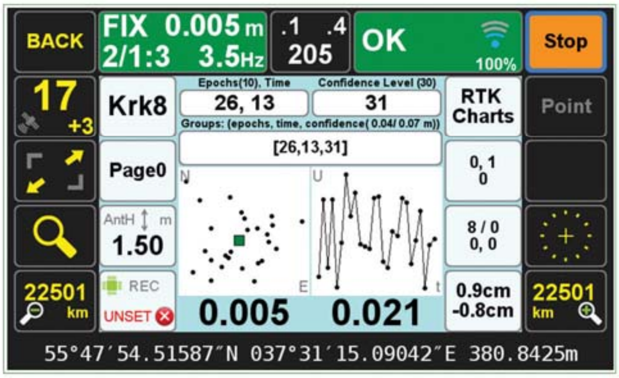


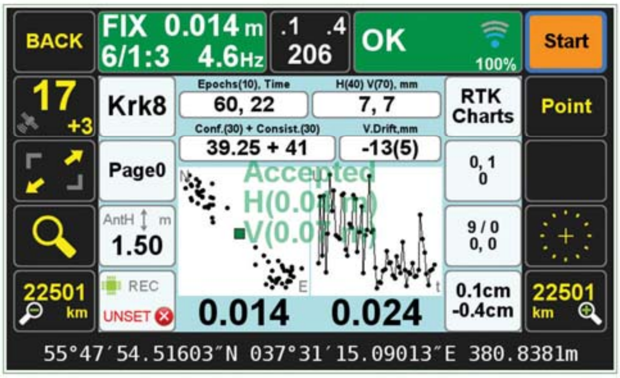
Phase-1 & 2 expanded vertical plot of each of the six engines

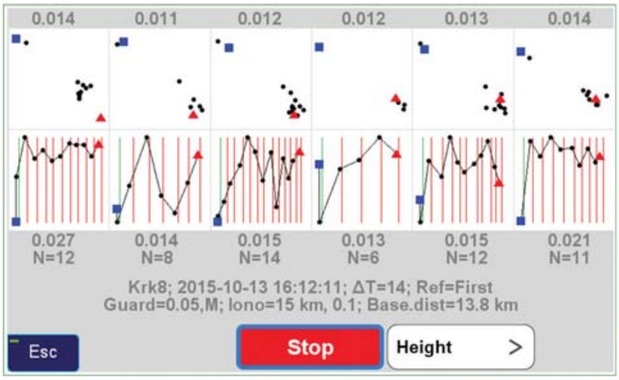
Example of exported HTML document. One page per point.

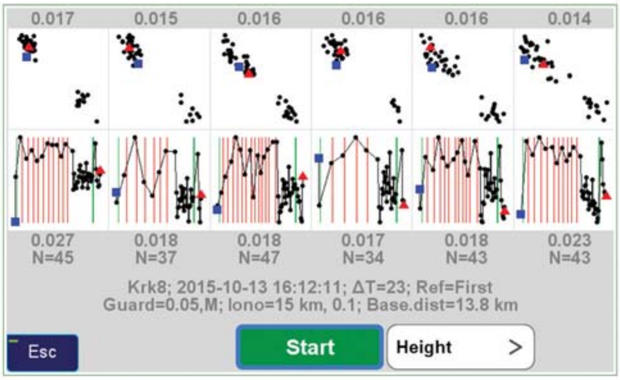
Name	Code and Description	Lat	Long	Alt
Krk8	--	55°47'54.51603"N	037°31'15.09013"E	380.8381 m

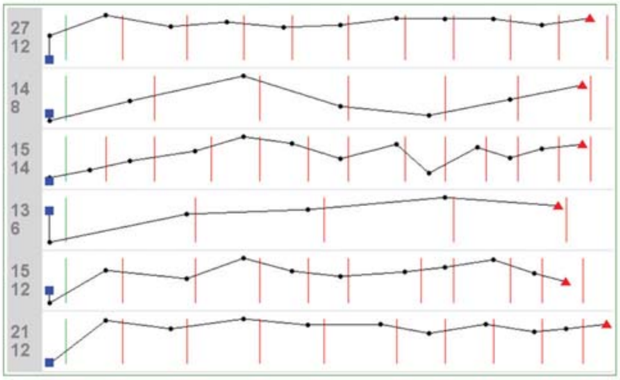
Page	Page0	Code	DefCode	Tag	--
WGS84 (ITRF2008)		55°47'54.52"N 037°31'15.09"E 380.84 m			
Base	55°54'02.82"N 037°23'44.99"E 259.52 m				
Time	2015-10-13 16:12:34		Time UTC	2015-10-13 13:12:34	
Antenna	JAVTRIUMPH_LSA NONE		Ant.Height	1.500 m / Vert	
Epochs	60	Sats	11+6	Duration	22.800 s
Solution	FIX	Confidence	39.000	Consistency	41.000
HRMS	0.007 m	VRMS	0.007 m	3dRMS	0.010 m
HDOP	0.743	PDOP	1.289	GDOP	1.461
95% Confidence Ellipse		σ_1:0.014 m, σ_2:0.010 m, θ:24°26'5.845021", σh:0.013 m			

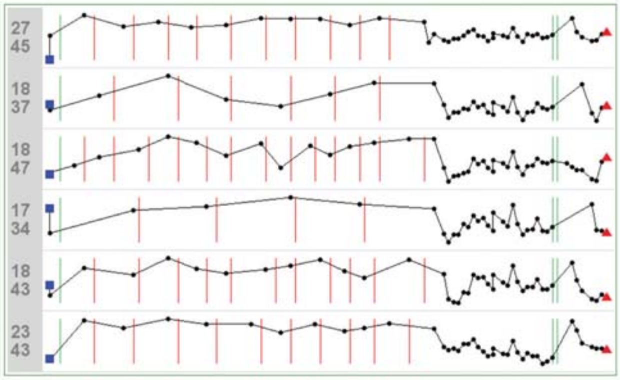












SBAS navigation performance evaluation in sub-saharan Africa

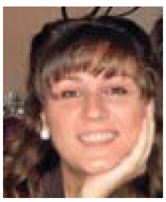
This paper presents some results of the scientific research conducted by Training on EGNOS-GNSS in Africa (TREGA) laboratory members concerning the feasibility of a potential Satellite Based Augmentation System (SBAS) in Sub-Saharan African regions

This document presents some results of the scientific research conducted by Training on EGNOS-GNSS in Africa (TREGA) laboratory members concerning the feasibility of a potential Satellite Based Augmentation System (SBAS) in Sub-Saharan African regions as part of its 'training through research'.

The first part of the study includes indicative results of a possible SBAS performance following 'ICAO SARPs requirements (Annex 10)' [1].

Real data from different African networks [2][3][4] have been analysed during solstitial and equinoctial months of the year 2013, characterized by high solar activity in the present solar cycle. In particular, the months of July and October 2013 have been used to represent different ionospheric seasonal conditions.

Two algorithms have been selected for the assessment of the SBAS system performance: an EGNOS-like processing set corresponding to the version 2.3.2 [5] and one specific version produced to optimize the performance in low-latitudes [5]. The use of these two algorithms was part of the training through research conducted in TREGA project.



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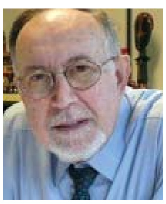

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The second part of the paper emphasizes on the ionospheric irregularities effects that degrade the SBAS performance at low-latitudes, particularly during post-sunset hours. It is well known that Total Electron Content (TEC) is a good indicator of ionosphere conditions and is widely used in studies of the near-Earth plasma environment. While for the analysis of the ionospheric irregularities, rate of change of TEC (ROT) has been taken into consideration and rate of change of TEC index (ROTI) has been chosen as an indicator for the presence of ionospheric irregularities. [6][7]

Different scenarios characterized by various geomagnetic disturbed periods have been selected in order to evaluate different ionospheric conditions and possible degradation or improvement of the SBAS system performance. Particular emphasis is given to the existing geomagnetic indices for those periods. Several indicators (Kp, Dst, Ap) [8] have been considered in order to evaluate the status and behavior of the ionosphere and to understand if there is a possible correlation with the SBAS system performance.

SBAS performance assessment

This document shows real data analysis of July and October 2013. The data were obtained from available GNSS receivers of NIGNET, SONEL and AFREF/IGS networks [2][3][4]. The year 2013 was selected because it corresponds to the first peak of the solar cycle 24. July and October were used to represent two ionospheric seasonal conditions:

Table 1: GNSS sites used in the Sub-Saharan African scenario

ID	Location	Network	Geo. Lat (oN)	Geo. Lon (oE)	Modip (o)
cggn	Toro (Nigeria)	NIGNET	10.12	9.12	-1.96
ouag	Ouagadougou (Burkina Faso)	AFREF/IGS	12.35	-1.51	2.86
futy	Yola (Nigeria)	NIGNET	9.35	12.50	-3.34
bkfp	Kebbi (Nigeria)	NIGNET	12.47	4.23	3.50
ykro	Yamoussoukro (Cote d'Ivorie)	AFREF/IGS	6.87	-5.24	-10.63
unec	Enugu (Nigeria)	NIGNET	6.42	7.51	-10.89
bjco	Cotonou (Benin)	AFREF/IGS	6.23	2.27	-11.83
dakr	Dakar (Senegal)	AFREF/IGS	14.75	-17.49	11.86
nklg	Libreville (Gabon)	AFREF/IGS	0.35	9.67	-23.90
fg07	Sao-Tome (Sao-Tome)	SONEL	0.34	6.73	-24.60

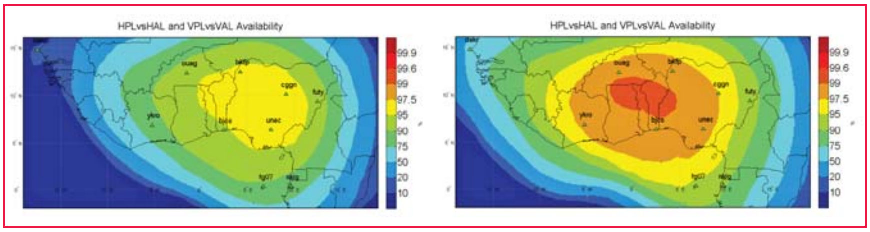

Figure 1: APV-I availability maps for the month of July 2013 EGNOS-like processing version 2.3.2 (left), and low-latitude algorithm (right) during 24 hours (from 00:00 to 23:59 UT).

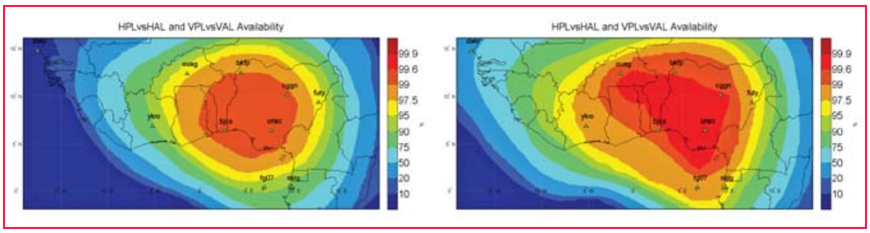

Figure 2: APV-I availability maps for the month of July 2013 EGNOS-like version 2.3.2 and low-latitude algorithm (right) during 14 hours from 04:00 to 18:00 UT.

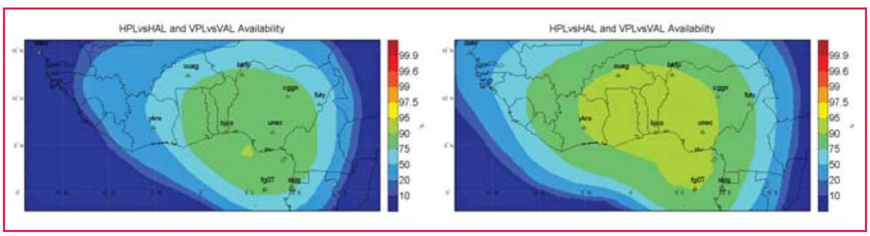

Figure 3: APV-I availability maps for October 2013 EGNOS-like version 2.3.2 and low-latitude algorithm (right) during 24 hours (from 00:00 to 23:59 UT).

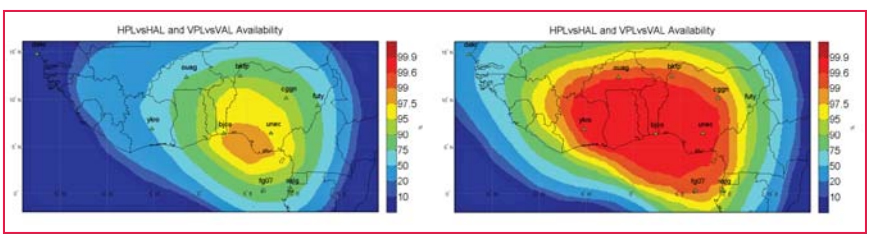

Figure 4: APV-I availability maps for October 2013 EGNOS-like version 2.3.2 (left) and low-latitude algorithm (right) during 14 hours from 04:00 to 18:00 UT.

solstice and equinox. The selected stations fall within the borders of the Northern and Southern crests of the Ionospheric Equatorial Anomaly (IEA) affecting low-latitude regions [9].

The details of the stations are shown in Table 1; it is important to emphasize that this particular scenario was designed following TREGA area of interest (Sub-Saharan African region), the spatial availability and the quality of the GNSS observables in the area.

Two algorithms have been used for the analysis of SBAS system performance: the EGNOS-like processing set version 2.3.2 and one specific version produced to optimize the performance in low latitude regions [5].

Figure 1 shows the difference between the two algorithms on SBAS system availability according to APV-I level of service (Horizontal Protection Level - HPL < 40 meters and Vertical Protection Level - VPL < 50 meters) for July 2013. Figure 2 shows the same monthly availability of July but considering only 14 hours (04:00 - 18:00 UT) in each day; i.e., discarding the periods of post-sunset to post-midnight.

For July 2013, it is shown that for both algorithms during daytime period the availability is above 99% in the area that contains a sufficient number of stations. Including post-sunset and post-midnight hours, there is degradation in availability of around 2% - 5%, less pronounced for the low latitude algorithm.

Concerning October 2013 (the selected equinoctial month), Figure 3 shows the monthly SBAS system availability using the two algorithms. Figure 4 shows the same system availability but considering 14 hours day (04:00 - 18:00 UT); i.e., discarding the periods of post-sunset to post-midnight.

It is clearly shown that for October 2013, EGNOS-like processing set availability is around 10% - 15% lower than the one calculated using low-latitude algorithm. Moreover, only taking the daily hours, it is observed that availability increases by

10% with both algorithms (being 99% in the area with sufficient number of stations using the low-latitude algorithm).

It is obvious that there is a clear degradation in post-sunset and post-midnight hours using both algorithms when analysing October 2013 (10% - 15% in comparison to results from July 2013. The next section covers in details the phenomenon).

The monthly performance is a reliable indicator of a SBAS performance. However, it is important also to analyse some specific days within the two months. There are some cases in which the daily availability differs notably from the monthly average. These cases correspond to an enhancement or an inhibition of ionospheric irregularities that are present, especially in the post-sunset and post-midnight periods. In particular, July 6th and 14th are characterised by inhibition of the irregularities, while July 10th by enhancement. October 2nd and 9th are characterised by an increase of irregularities, while October 14nd and 30th by their inhibition. Figure 5 shows the daily availability considering APV-I level of service of July 6th (inhibition) and July 10th (enhancement). Figure 6 shows the daily availability considering APV-I level of service of October 9th (enhancement) and October 30th (inhibition).

Ionospheric effects on SBAS performance

The ionosphere over Sub-Saharan African region, being under the effects of the IEA, is a major source for GNSS radio-wave signals from satellite to Earth. At these latitudes, the ionosphere is characterised by the presence of irregularities, in particular near the crests of the IEA. It is well known that most part of the strongest irregularities occur in the post-sunset period of the equinoctial months with high solar activity [10].

For this reason, the ionosphere of the Sub-Saharan region was evaluated to estimate its effect on the SBAS system degradation during post-sunset and post-midnight hours (Figure 1, Figure 2). The Total Electron Content (TEC) is a parameter widely used in studies of near-Earth plasma environment [11]. It describes how the ionosphere responds to solar and geomagnetic conditions and it is responsible for range error that produces a time delay in the radio signal. In this work, the time series of Rate of Change of TEC index (ROTI) was taken as a proxy for the presence of ionospheric irregularities. The time-derivative of TEC, the ROT and its standard deviation (ROTI) are:

$$ROT = \frac{TEC_k^i - TEC_{k-1}^i}{t_k - t_{k-1}} \qquad (1)$$

$$ROTI = \sqrt{< ROT^2 > - < ROT >^2} \qquad (2)$$

ROTI helps to identify and to statistically present the smaller scale irregularities [6] [7]. Moreover, ROTI automatically eliminates the unknown TEC biases, mitigates the slowly varying background trend of TEC, and emphasizes the high frequency components of TEC fluctuations.

The monthly ROTI averaging all stations is shown in Figure 7. The presence of irregularities explains the difference in SBAS availability between 24-hour analysis and 14-hour analysis (discarding post-sunset and post-midnight period). This is in accordance to ICAO task force indications on ionospheric effects for GNSS aviation [9]. The degradation in availability is higher in October than in July due to the difference in the level of irregularities (Figure 7).

Finally a study concerning geomagnetic indices has been done (Figure 8). These indices are often used in order to evaluate and understand global and regional level of ionospheric disturbances [12]. They characterize the contribution of different magnetospheric and ionospheric currents to the H component of geomagnetic field. The intensity of the electric fields and currents, as well as the magnetospheric ring current, is strongly dependent on the variations of the interplanetary magnetic field (IMF). This is due to several effects including magnetospheric convection, ionospheric dynamo disturbance and various kinds of wave disturbances [13].

The magnetospheric ring current cannot directly penetrate the equatorial ionosphere being; instead it is strongly related to the auroral ionosphere. The prompt penetration of the convection electric field from high latitudes to equatorial latitudes during geomagnetic disturbances causes the F

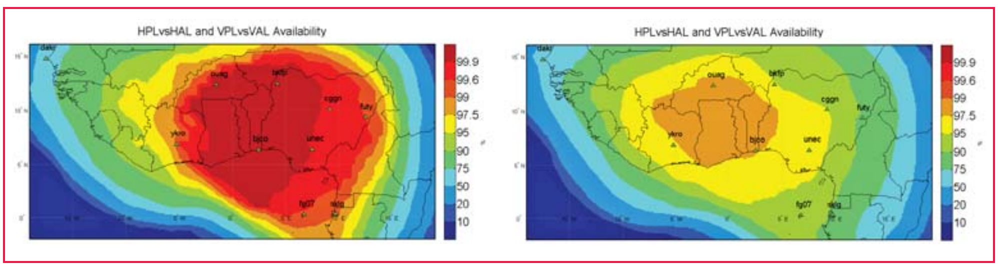

Figure 5: APV-I availability maps for July 6th (left) and July 10th (right), respectively inhibition and enhancement of the usual ionospheric irregularities in the Sub-Saharan African region.

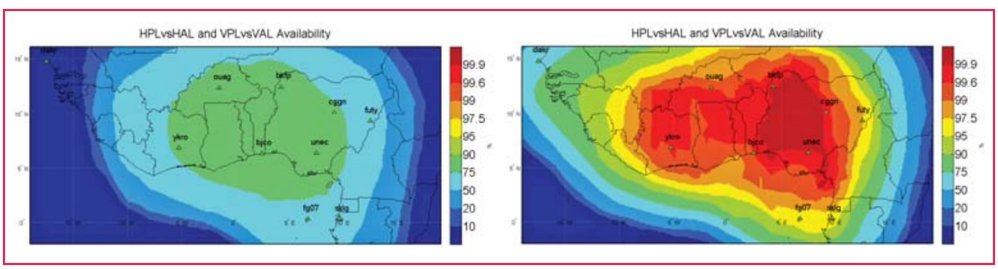

Figure 6: APV-I availability maps for October 9th (left) and October 30th (right), respectively enhancement and inhibition of the usual ionospheric irregularities in the Sub-Saharan African region.

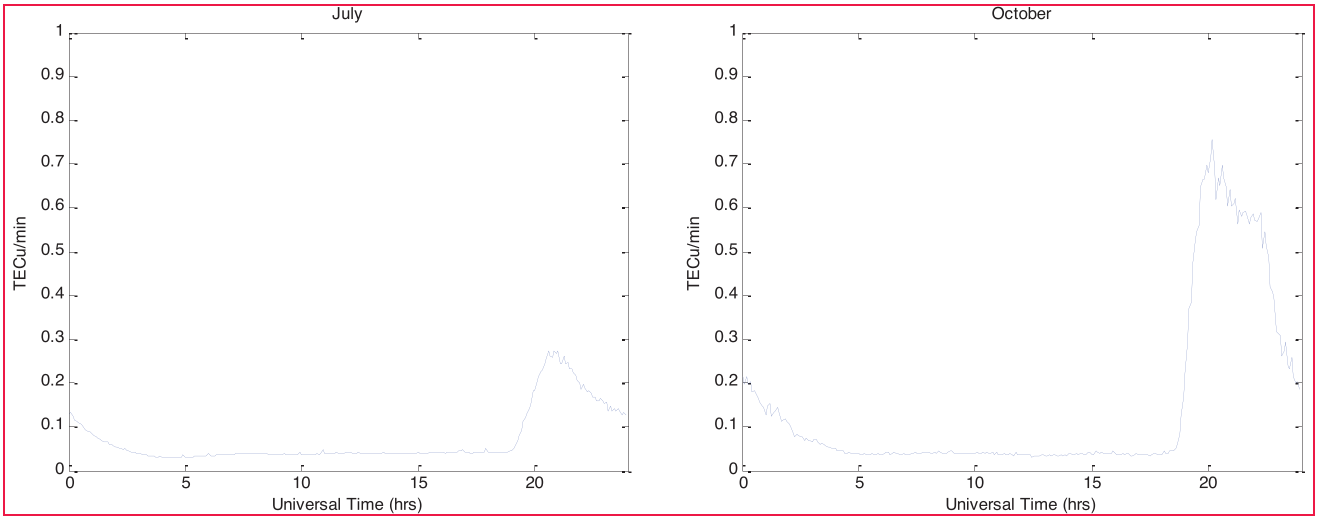

Figure 7: Diurnal mean ROTI of all the stations for July 2013 (left) and October 2013 (right).

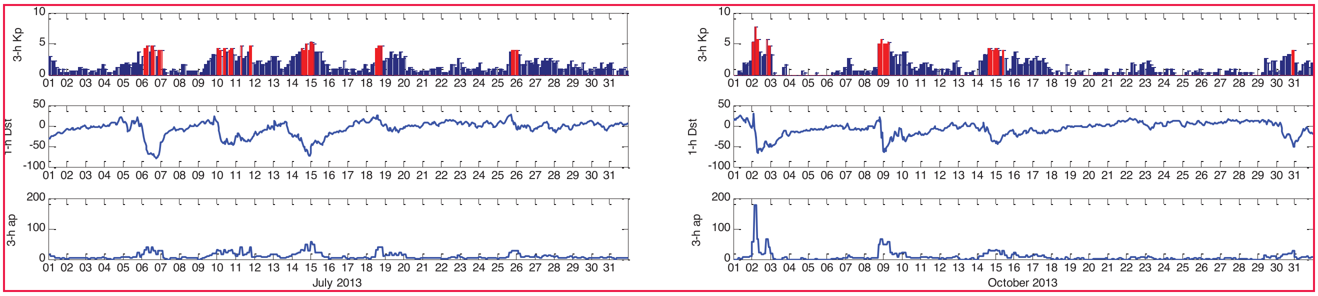

Figure 8: Kp, Dst and ap indices for July (left) and October (right) 2013.

region plasma modifications, and up-lift or down-lift of the ionosphere during daytime and night-time with correspondence to the eastward and westward electric fields [13].

In order to investigate such phenomena, various empirical relations in terms of different indices [8] have been used. An analysis of geomagnetic indices has been done to compare their behavior and possible correlation with the SBAS system performance in case of quiet and disturbed conditions.

Figure 8 includes relevant indices for July and October 2013 (Kp, Dst, ap) [8]. By analysing the SBAS performance (Figure 5, Figure 6) in the area, it is shown that standard indices are not consistent indicators of ionospheric conditions and their behavior does not find a correspondence with the SBAS system availability in the Sub-Saharan African scenario analyzed in this paper.

For instance, there is a different effect on the daily system availability during different disturbed conditions with similar Dst values (see Figure 5 and Figure 6 for the system availability), in October (9th, 30th) and July (6th, 10th) 2013. In these days, the system performance notably enhances or degrades with respect to the monthly average for the cases analyzed (Figure 5, Figure 6). This effect is in accordance with the studies carried out for mid-latitudes [12].

Conclusion

Results of a possible SBAS performance assessment in Sub-Saharan African region for the months of July and October 2013 indicate a difference of 10% - 15% in APV-I availability between solstitial and equinoctial month using both algorithms.

In October 2013, the SBAS can approximately provide similar levels of APV-I availability than in July 2013 during daytime hours (from 04:00 UT to 18:00 UT). This behavior follows the level of ionospheric irregularities present from post-sunset to post-midnight.

ROTI has not only been proven as a good proxy for the presence of ionospheric irregularities but also as a representative index of the system availability. ROTI can be used to measure and monitor ionospheric irregularities under disturbed space weather conditions.

In addition, the presence of ionospheric irregularities and their effect on the SBAS system performance cannot be consistently related to the geomagnetic activity indices values.

It is expected that use of a more dedicated network (high quality in GNSS observables) and more adequate distribution of the stations in the Sub-Saharan African region would improve the performance of the potential SBAS analyzed in this paper.

Being the study indicative, it should consolidate with a much larger statistic that could impact some of the conclusions.

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In Coordinates

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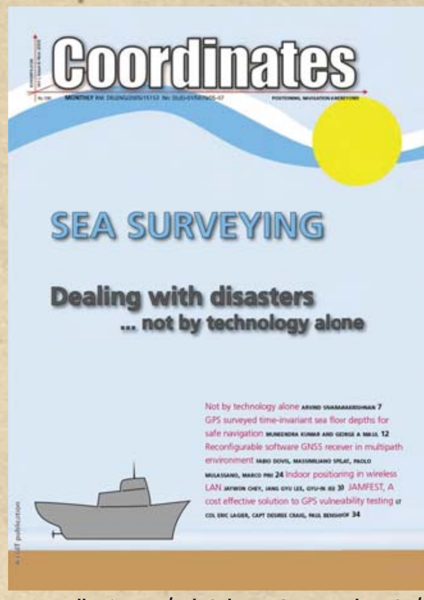

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DISASTER MANAGEMENT

Not by technology alone

Natural disasters happen all over the world, but the extent of damage and loss of life has far more to do with the preparedness and responsiveness of the relevant human systems, not only where the disaster happens but also often half-way across the world

ARVIND SIVARAMAKRISHNAN

Accountability and the price of neglect

It is, further, worth noting that while we can criticize states for their failures over natural and other disasters, the private sector – which so dominates the rhetoric of contemporary political economy and is so quick to exploit technology in the service of profit – is deafeningly silent after every disaster. Moreover, it has been noted in other contexts that criminal law cannot cope with culpability on a very large scale. The nature of its concepts of individual intention and possibly also of causation, even in questions of gross negligence such as those which arise in our responses to natural disasters, render it at best an awkward instrument with which to enforce accountability in respect of large-scale failures in the public or private sectors. Yet the fact remains that states, being publicly-constituted entities, at least have to answer in some way, even if their answers are often grossly inadequate. We might feel powerless to alter the conduct of states, but unless we attempt serious engagement with institutions and processes of state we too shall be complicit in the failures of maintenance, supervision, and organization which so often precede catastrophic disaster and exacerbate its effects so greatly.

SURVEYING

GPS surveyed time-invariant sea floor depths for safe navigation

This article describes the surveying mode to establish time-invariant ellipsoidal depths or heights of the sea floor in the open ocean

MUNEENDRA KUMAR, PHD AND GEORGE A MAUL, PHD

Conclusions

GPS and DGPS surveys provide the accuracy necessary for the ellipsoidal depths and ship operations, whereby all measurements are referenced to the WGS 84 Ellipsoid. Thus, an invariant zero reference surface (or a vertical datum) will eliminate the necessity of measuring tides and ship's draft, settlement(s), and squat during bathymetric surveying. In addition, this approach will replace any the time-variant tidal surfaces. The ellipsoid as the zero reference surface also allows the mariner, while underway, to determine keel and overhead obstruction clearance independent of the stage of the tide, and the draft of the ship and freeboard. As is traditional however, the prudent seaman will seek independent verification of all the available nautical information.

LBS

Indoor positioning in wireless LAN

There are difficulties in applying GPS directly to indoor positioning because of the weakness of GPS signal in an indoor environment

JAYWON CHEY, JANG GYU LEE, GYU-IN JEE

GNSS

Reconfigurable software GNSS receiver in multipath environment

The paper discusses the Software Defined Radio implementation of a reconfigurable GNSS user terminal integrating both navigation and communication capabilities

FABIO DOVIS, MASSIMILIANO SPELAT, PAOLO MULASSANO, MARCO PINI

Drones in support of upgrading informal settlements: potential application in Namibia

We describe a rapid test of using an unmanned aerial system (UAS) to acquire geospatial data that can be used to facilitate planning, upgrading and to promote tenure security

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Anna Muller
Shackdwellers Federation of Namibia

The number of people living in informal settlements around the world is difficult to measure precisely, but some estimates put it at close to one billion, or almost one quarter of the world's urban population. Informality is a phenomenon that has become a common characteristic of large cities in developing countries. UN-Habitat estimates that one third of all city inhabitants in the developing world live in an informal situation. People who live in 'slums', 'favelas', 'pueblos jovenes', 'shanty towns', and 'squatter settlements' all lack basic public infrastructure and services, live in inadequate housing and have no tenure security.

The UN Millennium Development Goals (MDGs) expressly addressed the problem of informality by setting one of the targets as "a significant improvement in the lives of at least 100 million slum dwellers" by 2020 (UN 2015). This goal has already been exceeded, but millions of people still live in slums. In the post-MDG era, the UN is promoting a "transformative approach" within the so-called sustainable development goals (SDGs) (UN 2014). Goal 11 of the SDGs is to "make cities and human settlements inclusive, safe, resilient and sustainable." (UN 2014, 14) It is clear from both the MDGs and SDGs that informal settlement upgrading is still high on the global policy agenda.

In many ways informal settlements are symptomatic of broader socioeconomic problems in society–poverty, inequality, and governance failures to name just three. The complexity of factors contributing to the rise and expansion of informality across the developing world means that good policies at the global or national level are just a start to successful upgrading and social upliftment of the informal residents.

Communities, local governments and NGOs, who play a linking role between these parties, are arguably the crucial players in upgrading. Ultimately, the goal of upgrading is to promote the safety, health and security of all of the residents living in the community. In the short term, the objective is to provide the means for the incremental upgrading of the community.

This paper describes the development and scope of informal settlements in Namibia and then proposes a novel approach to providing geospatial information to facilitate planning and upgrading of these settlements.

Upgrading of informal settlements

One of the fundamental principles behind incremental upgrading is to minimize the relocation of its residents and, if relocation is necessary, to relocate as close to the existing site as possible. However, relocation is typically required if the settlement is located in an environmentally sensitive area or in an area which is highly vulnerable to natural disasters like floods or hurricanes. The initial focus in upgrading should be on understanding how the settlement was formed, its relationship with the land owner and municipality, how it is organized and what services, if any, exist (NUSP 2015). Beyond that upgrading typically includes the following components:

- Planning and designing the upgrades
- Improving public infrastructure (roads, water, power)
- Land tenure regularization
- Upgrading of housing and shelter conditions
- Capacity development

Planning and designing upgrades involves designing streets and blocks in an area where settlement has occurred sporadically over time with little regard to vehicular access and in many cases no easy accessbyemergency vehicles. Planning, infrastructure design, tenure regularization, housing design andlocationand capacity development all require information and the participation of the inhabitants. UN-Habitat, through its Global Land Tool Network (GLTN), has developed a "participatory enumeration" toolthathelps compile basic information required for upgrading by involving the local inhabitants in the organization and collection of this information (UN-Habitat/GLTN 2010). This serves to build trust between external technical specialists and the inhabitants, but it also produces more reliable information and greater acceptance of the process and products. It is not only an information gathering activity but also a process for addressing conflicts and promoting consensus. One major challenge highlighted by GLTN is to ensure that the information collected in the participatory enumeration can be used to strengthen tenure security (GLTN 2014). This requires a flexible approach which recognizes a continuum of rights expanding the options for tenure security by offering alternatives to full private title, which can be expensive, time consuming and require standards that are not attainable in the short term in informal settlements. Instead, tenure security can be improved through recognizing some of the rights in the bundle of property rights, such as use and occupation, through a registerable certificate documenting these rights.

The participatory enumeration tool has been used effectively in several countries, including the Philippines, Thailand, and Brazil (UN Habitat/GLTN 2010). Lessons learned from this experience include:

- Strong partnerships with local authorities arecrucial
- The enumeration tool should be designed with the community so that it builds on local knowledge
- Training of enumerators is important and ultimately determines the quality of the data
- The data should be produced in a timely manner, which may require segmenting the work into smaller units
- Communities need to be trained to communicate effectively with other actors, such as local authorities
- The upgrading strategy may need to be promoted through advocacy (UN Habitat/GLTN2010)

Informality in Namibia

Namibia's urban history is comparatively recent, but informal settlements have been a characteristic of settlement patterns since 1890 when the German occupation led to the development of colonial towns where the workforce for the white occupants was sheltered in informal settlements (Muller 1995).This pattern continued until the implementation of the South African apartheid policies in Namibia inthe1960s resulting in the replacement of informal settlements with racially divided townships. These townships were planned and surveyed and remained the property of the local authority who rented out the houses. Registration of properties in these townships only commenced only in the late 1970s.

Although apartheid rules began to be relaxed in the late 1970s, urban development was generally still strictly controlled and any informal structures were demolished. This led to over-crowding in cities like Windhoek where a 56 square meter house might be occupied by as many as 12 people (Simon1991). Informal settlements arose in traditional land areas which fell outside the formal planning and development controls that were applied to formal townships (Van Asperen 2014).

When Namibia gained independence in 1990, those in need of better income opportunities or shelter acted on their new freedom of movement and migration to urban areas increased. Local authorities, which previously demolished any unapproved structure, recognized that they could not meet the demand for shelter and so permitted the building of informal structures within formally planned areas. The first community initiative on land and housing, called *Saamstaan* (Standing Together), started in 1987. Their strategy was to acquire a communal plot which they could develop incrementally by themselves. Intheearly 1990s the newly formed Ministry of Regional, Local Government and Housing together with the para-statal National Housing Enterprise (NHE) and the City of Windhoek started a project to relocate in habitants from the overcrowded single quarters (hostels that accommodated male contract workers) tolots located on the western fringe of Windhoek. These households were permitted to construct temporary shelters while the National Housing Agency (NHE), a central government agency, would construct their houses as soon as they could afford these. When spontaneous settlements developed around these areas and another relocation project, the City of Windhoek responded by decriminalizing squatting and through their "Squatter Policy" implemented reception areas (Shipanga 2000). However, the households ontheseplots began to rent space to others thereby increasing the density of the settlement in the reception areas.

Upgrading initiatives and challenges in Namibia

A 'Development and Upgrading Strategy' was implemented in various parts of the country with bilateral assistance from Denmark, France and Luxembourg. These projects focused on in-situ upgrading, although numerous households had to be relocated to meet the required standards for infrastructure.This experience showed that planning around existing structures

Figure 1: Map of Namibia showing major urban centers androads

was challenging and there was a shift tore-designing the area without considering the existing settlement patterns. However, upgrading in the northern towns (Oshakati, Rundu and Katima Mulilo) was mainly done in accordance with existing settlement patterns (see Figure 1). One important aspect throughout all of these projects was the key role of the community in the process. This role was mostly formalized by the local authorities working through existing or newly formed community structures.

Two NGO organizations, Shack Dwellers Federation of Namibia (SDFN) and Namibia Housing Action Group (NHAG), emerged out of the early initiatives of *Saamstaan* and developed strategies that promoted community involvement in the process. The Shack Dwellers Federation was created in 1998 as part of a poor peoples' movement to promote the idea that decision-making and actions needed to be shared by the broader membership or community to make it more sustainable.

During the first phase (March 2007 to October 2008) of the Community Land Information Program CLIP) profiles of 235 informal settlements in 110 municipalities, towns, villages and settlement areas were compiled by the communities (Namibia Housing Action Group 2009). The second phase of CLIP includes structure numbering and mapping on aerial photographs (replacing the earlier practice of hand drawn maps) and door-to-door collection of socio-economic data and structure usage. Socio-economic surveys have been completed in 116 informal settlements in 64 urban areas. Once data is collected and verified by the community, that data is manually analyzed and the findings discussed with the community, local authorities and other stakeholders (e.g. regional councils). The focus of these discussions is mostly around the priority needs of the community.

Namibia's general population is becoming more urbanized with 43% of the population living in urban areas in 2011 versus 27% in 1991. The data collected by CLIP revealed that the informal population in Namibia was around 500,000, equivalent to about 25% of the Namibian population. The upgrading process is currently still taking place within the formal land development process which means that eventually existing service tariffs will apply which communities cannot afford (Chitekwe-Biti 2013).

Figure 2: Extracts of Google Earth imagery at different dates (A-E,G-J) and 2010 Orthophoto (F)

Another challenge is the lack of security of tenure experienced by households. The Ministry of Land and Resettlements started with a Flexible Land Tenure Program in the mid-1990s to facilitate a simpler system to register tenure for households living in informal settlements. However, the Bill to enable the registration was only enacted in 2012 and the regulations guiding the implementation are expected to be proclaimed in 2015. Due to this delay, the City of Windhoek started focusing on planning for formal subdivision and individualization, therefore limiting the potential for applying appropriate standards and leaving thousands of households in a situation where two households live on 300 square meter plots.

Where upgrading is taking place the households sign lease agreements but do not have the right to upgrade and develop their property. They are therefore reluctant to invest in any upgrading of shelter improvements.

Namibia lacks a common strategy for scaling up informal settlement upgrading in the country. The current slow pace of the formal land development process does not cater for scaling up upgrading and a dedicated longer term upgrading strategy is needed.

Mapping needs and availability

Map updating in a large and sparsely populated country like Namibia a costly per capita expenditure. Hence maps are only regularly updated in the major cities and towns of Namibia. In the 2010 enumeration of the Freedom Square upgrading project in Gobabis, the orthophoto maps used were produced from aerial photography dated May 2010 with a 0.5 m resolution (see Figure 2F). In addition to this orthophoto, satellite imagery such as that displayed on Google Earth could also have been used. Figure 2 shows extracts of a sequence of the available satellite imagery and orthophotos that are available for the Gobabis area.

While the Google Earth satellite maps may be somewhat inferior in resolution and radiometric quality to the 0.5 m orthophoto (F in the figure 2), they are more frequently updated than the mapping that is typically done in Namibia. Comparing the quality of the Google Earth imagery dated 2009 (E in the figure 2) with that of the 0.5 m conventional orthophoto, one might argue that it was not necessary to incur the costs of producing the 0.5 m orthophoto. However, relying purely on Google Earth as the mapping source for settlement upgrading is not without problems. Firstly, the timing of updates cannot respond to the demands of small, under funded local project leaders. And since one cannot predict when Google Earth will render fresh maps one often has to either accept outdated or inadequate maps or provide for new mapping altogether. Secondly, the quality and spatial reference of the Google Earth satellite imagery is not constant. Hence the suitability of any given satellite map rendered by Google Earth has to be assessed specifically for each project, both in terms of resolution and currency.

Despite the above short comings, Google Earth is a valuable source of geospatial information often over looked in upgrading projects. Not only does Google Earth provide free access to an archive of satellite imagery taken over long periods of time, it also provides a very good viewer for visualization, basic drawing tools for the lay person as well as a widely used data standard (kml) for easy dissemination of geo-spatial information over the internet.

National mapping agencies typically try to update maps at regular intervals. To exploit savings through scales of economy, mapping contracts are typically issued to cover large tracts of land at uniform quality and resolution. More often than not mapping contracts of this kind are subject to complicated procurement procedures that often take more than a year to complete. Further more, many developing countries lack mapping capacities and hence have to rely on foreign companies, thus imposing even more bureaucratic complexity on the map acquisition

Figure 3: Flight Lines for Fixed Wing UAVTest

Figure 4: UAS-based Or thophoto

Figure 5: Block plan over laid on UAS Or thophoto

process. The result of these impediments is that often projects are carried out with maps that are outdated or of inadequate resolution and accuracy or just not available due to delayed delivery. This is especially true for informal settlements which change very rapidly and require large scale mapping.

Satellite imagery and aerial photography have been used in the past as the basis for mapping and planning informal settlements. However, the inappropriate scale and lack of currency make it challenging to work with this imagery. Google Earth, which is emerging as a very useful source of spatial data, often has the same shortcomings of currency and resolution. Fortunately, a new option has emerged which can provide current spatial information at an unprecedented resolution. The emergence of unmanned aerial vehicle (UAV) and computer vision technologies has the capacity to overcome these impediments and provides the ability to augment satellite imagery for detailed urban design, rural planning and land administration tasks.

Rapid UAS test in Gobabis

Gobabis Town is situated in eastern Namibia approximately 200 km east of Windhoek (see Figure 1) and is the regional capital of the Omaheke Region and the core of Namibia's "cattle country." This municipality has four informal settlements incorporating approximately 9,000 people, including Freedom Square which is the oldest of the four settlements. CLIP covered all four informal settlements in Gobabis. Feedback meetings within the CLIP process provided a forum for the community to express its anger and frustration with the proposed relocations by the municipality. During an exchange visit in March 2013 to Cape Town and Stellenbosch, facilitated by SDI (Shack/Slum Dwellers International), participants were exposed to communities and local authorities using enumeration and mapping information collected by the community to upgrade and plan their settlement. As a result of this exchange, the Gobabis Municipality agreed to upgrade the informal settlement through re-blocking, and to sign a Memorandum of Understanding with NHAG/SDFN. This provided an opportunity to test a novel approach to mapping informal settlements and providing geospatial information for planning and upgrading.

Unmanned Aerial Systems (UAS) or drones are a convergence of navigational, positioning and model airplane technologies that provide a much more affordable and faster approach to mapping (Volkmannand Barnes 2014; Barnes, Volkmann and Barthel 2013). Most importantly, they offer a transparent methodology that can be quickly deployed. In dynamic situations like informal settlements a high resolution map can be obtained that is current to within less than a week of flying. The orthophoto map derived from the UAS aerial imagery is also much more understandable than mathematical coordinates or imaginary lines drawn between property corners. Additionally, it provides valuable information ontheroof type, house area, fences, paths and tracks, and other features that feed into the planning and adjudication processes.

Namibia is fortunate to have a small group of model airplane enthusiasts (amongst them a land surveyor)who have exploited the large open spaces to pioneer the use of open source and do it yourself (DIY) UAV technology for aerial mapping and aerial surveillance for the protection of endangered wild life. The UAV community in Namibia has the capacity to design, configure and assemble multi-rotor as well as fixed wing platforms for Namibian applications.

We carried out a small pilot test in Freedom Square surrounding Gobabis to assess the potential for using small drones to facilitate incremental upgrading in informal settlements. It took the co-author and some volunteers about a day to survey some 60 evenly distributed Ground Control Points (GCPs) across the Freedom Square area. Where possible, permanent and well defined features, such as manhole covers and disbanded tires (popularly used as flower beds), were used as targets. Most of the GCPs, however, consisted of white 20 cm paper plates secured to the ground with a 15 cm long nail. This survey was referenced to the local datum using post processed dual frequency GPS. During this survey the community was briefed on the UAV mapping process. Throughout the flying the weather was uncharacteristically windy and thus a considerable number of targets were disturbed either by children or by the wind before the image acquisition could be completed.

After on-site assembly of wings and fuselage the fixed wing UAV (known as *Bateleur*) was launched by catapult for a 20 minute flight at an altitude of 150 m covering approximately 100 hectares producing 4 cm GSD aerial imagery with 70% side- and 80% forward overlap. The flight ended with a perfect automatically executed landing which earned applause from the large number of community inhabitants who had gathered around the launch area. After downloading and inspecting the aerial imagery a second flight was performed to cover an additional 90 ha of land with aerial imagery of 4 cm GSD. Approximately 600 aerial images with 45 mm resolution (ground sampling distance or GSD) were acquired.

Figure 3 shows the logged flight path above Freedom Square as recorded by the flight controller on board the Bateleur. In its current configuration it has a take-off weight of 2.5 kg, an endurance of over thirty minutes and flies safely at an airspeed of 14 m/s carrying a 20 MP camera as payload. It can thus cover a distance of over 25 km in one flight. It is made of material strong enough to endure full speed crashes and can be repaired in the field. The wing mountings are designed to disengage from the fuselage on impact, thus reducing the likelihood of damage andinjury.

Using a 'Structure from Motion' (SfM) software suite (Agisoft's Photoscan), these images were processed overnight to produce a high quality 4 cm orthophoto (see Figure 4) and digital surface model of the Freedom Square area. This orthophoto could have been delivered to planners, engineers, community members and administrators within less than 24 hours after the imagery was acquired.

This UAS-based orthophoto is now being used by the Shack Dwellers Federation to finalize a formal block plan and to allocate formal parcels to the informal settler households. The proposed block plan is shown overlaid on the UAS-derived orthophoto in Figure 5.

Conclusions

Because this test occurred after the enumeration and lay-out planning phases of the Freedom Square project, we were unable to fully explore the potential value of the current, high resolution imagery and UAS products on the whole upgrading process. However, we are convinced that a UAS approach is superior to conventional approaches for the following reasons:

- It provides a resolution and currency unattainable by either aerial photography or satellite imagery
- It is cheaper than conventional approaches
- It provides a transparency and exposure to the community that is impossible with conventional approaches
- Capacity can be developed locally thereby avoiding long procurement processes and building on local knowledge

We are optimistic that over the next year we will be able to test this UAS approach further and demonstrate how it can provide quality geospatial data for tools such as the social tenure domain model (STDM).

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At a Glance

- Septentrio has appointed Unmanned Systems Source as an authorized dealer for GNSS positioning products in the UAV market
- Ordnance Survey Selects SimActive's Correlator3D
- Topcon introduces control box for excavator systems for US
- Philippines gets Senix sensors for flood warning
- Trimble TMX-2050 now equipped with TeamViewer's QuickSupport
- MAPPS selected for FAA Registration Task Force
- Global Mapper LiDAR Module V17 released
- Technip, 3D at Depth to commercialize LiDAR in Gulf of Mexico
- Applied Software acquires Enceptia
- IGAPP launches Vricon Explorer app
- Intergraph SG&I re-branded as Hexagon Safety and Infrastructure
- Abu Dhabi updates seismic activity reader
- Luciad introduces 3D visualization to the Internet of Things
- Hexagon bags Wichmann Innovations Award at INTERGEO 2015
- MDA expands imaging modes for RADARSAT-2 satellite
- DigitalGlobe partners with Mapbox for 30 cm imagery basemaps

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Geoinformation is the international language of decision-makers

INTERGEO 2015, 15 – 17 September, Stuttgart, Germany

Geoinformation is the global language that decision-makers all understand. This places the geoinformation sector, with its technologies and solutions, in a key position to deliver information that can be used to make decisions. The sector has strong wind in its sails – as the growth seen at INTERGEO 2015 clearly demonstrates. With 15 percent more exhibitors and floorspace, its broad international scope and thoroughly robust economic outlook, INTERGEO radiates the full dynamism of this innovation-focused industry. Stuttgart, 17 September 2015 – Geoinformation is the global language that decision-makers all understand. This places the geoinformation sector, with its technologies and solutions, in a key position to deliver information that can be used to make decisions. The sector has strong wind in its sails – as the growth seen at INTERGEO 2015 clearly demonstrates. With 15 percent more exhibitors and floorspace,

> "We have to actively combat the shortage of specialists and join forces with universities and companies to attract young talent"
> *- DVW President Thöne*

its broad international scope and thoroughly robust economic outlook, INTERGEO radiates the full dynamism of this innovation-focused industry.

There's no need for any crystal ball to predict geoinformation's continuing growth. Cutting-edge applications to meet society's needs for mobility, intelligent cities, digital construction, a sustainable energy supply, climate protection and disaster relief management all rely quite heavily on geoinformation. Prof. Dr.-Ing. Karl-Friedrich Thöne, President of host organisation DVW – Gesellschaft für Geodäsie, Geoinformation und Landmanagement e.V. (German Society for Geodesy, Geoinformation and Land Management), says: "Geoinformation is the servant of society – an indispensable motor for its sustainability and future-proof business sector. What's more, the end-to-end integration of geoinformation into diverse business processes lends the sector further force thanks to its ability to accelerate and simplify processes and reduce costs." Process optimisation and input into decision-making processes are the key tasks the geoinformation sector has proudly presented at INTERGEO in Stuttgart.

INTERGEO 2015: Unstinting growth

The facts and figures for this year's INTERGEO speak entirely for themselves. As it draws to a close today, the 21st INTERGEO has scored 15 percent growth in exhibitors and floorspace and attracted a very impressive 16,500 visitors. Many of the exhibitors have remarked upon the senior executive status of the contacts they have made at INTERGEO. The fact that half of the exhibitors travelled from abroad reflects INTERGEO's top calibre as leading international trade fair for geoinformation technology. One of the zones where foreign exhibitors really made their mark was the "UK Pavilion", which joined the trade fair again for the second time this year.

Objective: Customised results

The sector makes a concerted effort to integrate and implement developments in mainstream IT. The result is simple, user-friendly, intuitive solutions that seek to deliver customised responses to customers' requirements and those of Geospatial 4.0. "Our technology must respond to the needs of an expanding global population. And we're very optimistic we can do just that. INTERGEO, the key event where our international users gather under one roof, gave us the chance to demonstrate how we optimise workflows and simplify processes for our customers' benefit," said Eduardo Falcón, Executive Vice

President and General Manager of the GeoPositioning Solutions Group at Topcon Positioning Group.

Interaerial solutions: Platform for innovative businesses

The launch of the special exhibition zone interaerial SOLUTIONS the INTERGEO cements its status as the international communications hub for applications devoted to Unmanned Aerial Systems. Cina Molawi, a first-time exhibitor at INTERGEO with his start-up company “Sitebots”, reported that “INTERGEO is just the right platform for young, innovative companies involved in UAS. INTERGEO covers a broad spectrum of the industry – we welcomed a high proportion of decision-makers to our stand and succeeded in firmly positioning our products.”

A keen eye on: Recruiting young talent

Once again, one of the key concerns of many of the businesses at this year’s INTERGEO was the shortage of specialists – and the trade fair is becoming an increasingly important recruitment forum. “We have to actively combat the shortage of specialists and join forces with universities and companies to attract young talent,” says DVW President Thöne.

INTERGEO 2016: Keen interest in Hamburg

As one INTERGEO draws to a close, the next INTERGEO already beckons. With its future-oriented focus on digital construction and smart cities, INTERGEO 2016 is moving to Hamburg. INTERGEO 2016 will be held in Hamburg from 11 to 13 October

– Jens Lichte, *Communications Manager, HINTE Marketing - und Media GmbH*

Galileo update

Next Galileo satellite launch planned from Guiana on 17th December 2015

Next two satellites from Galileo program are going to be launched with Arianespace rocket from Guiana Space Centre launch site LCS.

After launching first satellite in 2011 Galileo is planned to provide services in 2016, furthermore in 2020 it is scheduled to complete all from 30 (24 operational and 6 spare) satellites. Notes fast pace to achieve full efficiency of the system – compared to Glonass which became fully functional (with 24 satellites). Of course Glonass and Galileo can not match with GPS which was finished in 5 years after launching first satellite in 1989, but still opposed to Glonass and GPS Galileo is cilivilian solution with civilian budget. First fourteen FOC satellites providing signal for Galileo navigation are made by OHB System and Surrey Satellite Technology Limited (SSTL), next eight are contracted to OHB System. On 17th December 2015 it is planned to launch 11th and 12th satellites. Importance of the program progress and previous successes sometimes perceived as unnecessary best summarize words spoken by Elżbieta Bieńkowska (European Commissioner for Internal Market, Industry, Entrepreneurship and SMEs) in March 2015. *www.satprnews.com*

GSA extends deadline for proposal for specialized GNSS chipsets

The European GNSS Agency (GSA) has extended its timeline, until November 20, for submission of proposals to develop two specialized European GNSS (E-GNSS) “engines” for ITS applications.

Partly funded under its €100 million “Fundamental Elements” program, the projects would build Galileo and European Geostationary Navigation Overlay Service (EGNOS) capability into specialized chipsets: an E-GNSS engine for safety-critical applications in road transportation and another for liability- and payment -critical applications in road transportation. Target participants are vehicle manufacturers, automotive suppliers, and GNSS receiver and chipset manufacturers.

The first grant would underwrite up to 60 percent (€4.5 million) of a single project to develop an engine for safety-critical ITS applications, while also analyzing the potential for E-GNSS “differentiators” (such as signal authentication, precise point positioning using a Commercial Service), developing the interface with a vehicle’s standard data exchange system (such as a CAN bus), and cooperating with GNSS/ ITS standardization efforts.

The second grant would provide €6 million for two similar projects to help develop a “liability- and payment-critical E-GNSS-based engine in the road sector.” All three projects would run for up to three years and focus on creating chipsets that would be embedded in dedicated on-board units, on vehicles or consumer devices on private and commercial road vehicles.

UAS for GPS-denied environments

The Pentagon in the USA has been pushing for the development of autonomous unmanned vehicles for a while. Now, it wants them to operate autonomously even when GPS signals are degraded.

The Army's Armament Research, Development and Engineering Center plans to use a think-tank and skunk-works approach (the latter a reference to Lockheed Martin's Advanced Development Programs) to "identify, invest, mature, and transition revolutionary/game-changing autonomous unmanned sensing technologies."

ARDEC's objectives include analysis and assessments, technology demonstration efforts to determine technical risks, and system integration requirements of existing and previously developed autonomous UAS. Ultimately, the program wants to expand the capabilities of GPS-denied autonomous sensing and collaborating architectures.

The notice makes clear that precision mapping, location, target detection, tracking and collaboration capabilities that work where GPS signals are denied are a requirement for today autonomous UAS sensing technologies, though they also open a pathway for new methods of sensing in existing and emerging threats. *https://defensesystems.com/*

All 7 IRNSS Navigation Satellites to Be in Orbit by March: Isro

Press Trust of India , 8 October 2015
All the seven satellites of Indian Regional Navigation Satellite System (IRNSS) are expected to be in orbit by March 2016, Indian Space Research Organisation said recently. ISRO also aims to make signals available not only to India and surrounding countries, but also to the entire globe, ISRO Chairman Kiran Kumar said.

GSAT-15 satellite with GAGAN payload is slated for launch by November 10, he said.

The space agency chief said "in this backdrop the activities are going on the way we need to take forward the objective of self-reliance. Not only self-reliance, but also trying to provide, extend the process of making this signals available not only within and surrounding our country, but also looking around the globe is also one of the important aspect we will be looking at."

India has entered into the realm of satellite-based navigation with its two "pioneering" projects GAGAN and IRNSS, officials said. *http://gadgets.ndtv.com/*

Chinese BeiDou BDS to transfer satellite tech. to Iran

Under an MoU signed Between Iran's IEI and Chinese BeiDou Navigation Satellite System (BDS), China will transfer its BDS technology to Iran. Under the memorandum, China will establish BeiDou ground stations in Iran, and Iran Electronics Industries (IEI, AKA Sa Iran) will found a center for space data collection. *http://en.mehrnews.com*

GLONASS & BeiDou to make satnav system parts together

China's BeiDou navigation satellite system and Russia's GLONASS plan to join forces and build a production facility. According to Dy. Prime Minister Dmitry Rogozin, it is planned that the facility for production of receiver modules and chipsets will be based in Russia. *https://www.rt.com/*

GPS III Launch Services RFP Released by Air Force

The U.S. Air Force GPS Directorate released a final request for proposal (RFP) for GPS III Launch Services in September'2015. Launch services include launch vehicle production, mission integration, and launch operations for a GPS III mission scheduled to launch in 2018. After evaluating proposals through a competitive, best-value source selection process, the Air Force will award a firm-fixed price contract that will provide the government with a total launch solution for the GPS III satellite.

China Launches 20th BeiDou Satellite

China launched a new-generation satellite into orbit that will support its GNSS network on September 30, 2015. According to the China state news agency Xinhua, the spacecraft was launched from Xichang Satellite Launch Center in the southwestern province of Sichuan on a Long March-3B carrier rocket. It was the 20th satellite for the BeiDou Navigation Satellite System (BDS) and for the first time featured a hydrogen atomic clock.

Global Mapper LiDAR Module V17 Released

Blue Marble Geographics has released an update to the Global Mapper LiDAR Module. The latest edition of the module includes numerous functional enhancements and performance improvements that have been designed to improve the quality and utility of LiDAR and other point cloud data. New and updated functionality includes a tool for automatically detecting and classifying power lines and other above-ground utility cables; a new set of analysis tools for identifying and filtering noise or erroneous points in LiDAR data; and an enhancement to the feature extraction tool that allows vector line features to be created a linear array of points such as a utility cable. *www.bluemarblegeo.com*

OGC adopts updated KML Earth Browser Standard – KML 2.3

The Open Geospatial Consortium (OGC) has approved the OGC KML 2.3 Standard.

KML is an XML grammar used to encode and transport representations of geographic data for display in an earth browser, such as a 3D virtual globe, 2D web browser application, or 2D mobile application. KML, an open, non-proprietary standard, is supported in numerous Earth browser applications and geospatial software products. In early 2007, Google submitted KML to the Open Geospatial Consortium (OGC) to be maintained and evolved within the OGC consensus process. 84 KML 2.2 implementations are currently registered in the OGC implementations database.

The main KML enhancements provided in version 2.3 are:

1. Addition of a new feature, KML Tour, which enables a user to specify aspects of a controlled virtual flight through a series of geographic locations, including speed, mode of flight (smooth or bounce), sound tracks and how KML features are updated throughout the tour.
2. Addition of new geometries: Track and MultiTrack. A KML Track can capture and display the path and other aspects of a moving object over a specified period of time.
3. Enhancements to KML's Extension Mechanism, allowing for the direct use of XML content from third-party schemas. KML 2.3 is now based on XML Schema 1.1 enabling authors of KML Application Profile extensions to experimentally add foreign element and attribute content interleaved among existing KML elements. *www.opengeospatial.org*

Japan to provide grant of $3 mln to help create national infrastructure for geospatial data of Ukraine

Japan International Cooperation Agency (JICA) will provide $3 million to realize a pilot project as part of the creation of the national infrastructure for geospatial data in Ukraine, Deputy Head of Diplomatic Mission and Advisor to Embassy of Japan to Ukraine Hiromi Nakano has said. "This is a grant, we do not demand the return of it," she said.

Wide-area high-accuracy positioning data on the way

Australia is placing orders for sophisticated satellite reception equipment designed to provide almost the whole of the Australian land mass with extremely accurate positioning data, fulfilling a long-held ambition of Australia's geodesy, surveying and satellite specialists. The equipment enables capture and processing of data from all the in-orbit satellite positioning data systems in operation now, or coming into service progressively over the next few years. It applies ground-based corrections from terrestrial stations whose position is calibrated exactly, and allows rebroadcast of ground-originated positioning signals to achieve the extreme accuracy specified.

The corrections are needed because tiny orbital shifts, random gravity effects in space such as lunar tidal effects, variations in the earth's atmosphere, and various other perturbations complicate the calculation of position from satellite-derived signals by themselves.

APEC calls for implementation of intelligent transport systems by member economies

Asia-Pacific Economic Cooperation (APEC) member economies are encouraged to implement the Intelligent Transport Systems (ITS) to enhance the efficiency and effectiveness of transport infrastructures, especially recognizing the significant safety and environmental benefits that may be realized simultaneously.

The ITS are advanced applications that aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and "smarter" use of transport networks.

Such systems vary in technologies applied, from basic management systems such as car navigation; traffic signal control systems; container management systems; variable message signs; automatic number plate recognition or speed cameras to monitor applications, such as security CCTV systems; and to more advanced applications that integrate live data and feedback from a number of other sources. *http://news.pia.gov.ph*

Russia found a solution to switch Glonass to domestically produced components.

The Russian GLONASS will fully switch to domestically-produced electronic components in the next two years, Deputy Prime Minister Dmitry Rogozin recently said. "We have found solutions for switching to a domestically-produced [electronic] component base within a year and a half or two years," Rogozin said at an international congress on the ERA-GLONASS system. *http://sputniknews.com*

TomTom Launches its traffic service in Hong Kong

TomTom has launched world-class traffic service in Hong Kong. It provides traffic information for highways, major roads and secondary roads in 48 countries.

TomTom Traffic includes congestion forecasting, which indicates whether a jam is growing or dispersing, and estimates how long a delay will last.

According to TomTom data, the busiest hour of the day for traffic in Hong Kong is between 8am and 9am, and during this hour the average total jam length is usually over 35 kilometres. On some days the total jam length can grow twice as long. *www.businesswire.com*

TRX Systems Releases New NEON® Indoor Location Solution

TRX Systems, developer of the NEON Indoor Location Solution, has released NEON Signal Mapper, a new software application delivering 3D indoor tracking and visualization for users mapping LTE, LMR, Wi-Fi, Bluetooth and other signal and sensor data, providing an easy-to-use application and API that saves time and increases accuracy. It enables users to cost-effectively, quickly and accurately map the measurements taken indoors where GPS is unavailable. *www.trxsystems.com*

GPS collars in Southern Highlands koala conservation program

The New South Wales Government in Australia is fitting the final 10 of 20 koalas with GPS tracking collars as part of its first study into the mammals in the state's Southern Highlands.

Koala numbers across the state have dropped in two decades and it is estimated there are fewer than 200 koalas left in the area. "The study aims to provide a clear direction for the long-term conservation of one of Australia's most iconic species," Environment Minister Mark Speakman said in a statement.

The collars will be fitted onto the animals over the next month and the data will enable researchers to track koala colonies and ensure their long-term survival. The project was established after a major fire in the Yerrinbool-Balmoral area in 2013 wiped out some of the koala population and forced many others to move.

European Satellite Navigation Competition 2015

The global satellite navigation community gathered in Berlin to recognise the year's most brilliant innovations in commercial applications of satellite technology. The project POSEIDRON won over the international jury of experts with its remote-controlled multicopter built to support maritimesearch-and-rescue services - and took home the grand prize ahead of the European Satellite Navigation Competition's 29 other winners.

Mr Enrique Martínez Asensi and his winning team hope to see Poseidron save lives far out at sea when people fall overboard or are involved in shipwrecks that occur during illegal immigration. Custom-developed by Sincratech Aeronautics - a start-up based in Valencia, Spain - POSEIDRON can be launched from ships or platforms under virtually any weather conditions.

In addition to winning the ESNC's EUR 20,000 grand prize, this innovative project will nowhave the chance to enter a 12-month incubation programme at one of five Science Parks in Valencia as part of the region's prize. The ESNC set another new participation record this year, with 515 innovations entered bycompanies from more than 40 different countries around the world. The competition thus more than matched the successes of editions past in increasing its overall figures to 272 winners awarded and 3,343 ideas received from over 10,000 participants throughout its 12 years in existence.

The ESNC presented prizes valued at approximately EUR 1 million in total at its festive Awards Ceremony. The competition's jury of some 240 renowned experts selected both the overall victor and 30 other regional and special prize winners. With their innovations in areas such as connected mobility, smart cities, tourism, and environmental protection, these entrants demonstrated how fundamental precise satellite navigation signals are to Europe's digital society. Please visit the ESNC website for an overview of this year's winners. *www.satellite-masters-conference.eu*

PCI Geomatics expands its exclusive agreement with China's Beijing Space Eye Innovation

PCI Geomatics has extended and expanded its exclusive distribution agreement with Beijing Space Eye Innovation Technology Co., Ltd. (BSEI) of China for an additional five years. The agreement acknowledges BSEI as PCI's exclusive reseller partner in China for both PCI's Geomatica desktop software and PCI's award winning GeoImaging Accelerator (GXL) technology. *www.pcigeomatics.com*

Iran to launch homegrown remote-sensing satellite next year

Iran plans to send its first domestically-made remote-sensing satellite "Tolou 1 (Rise 1)" into orbit in the first half of the next Iranian calendar year, which will begin on March 20, 2016, the head of Iran's National Space Center announced.

Iran successfully launched into orbit its first indigenous data-processing satellite, Omid (Hope), back on February 2, 2009. *www.tasnimnews.com*

RS satellite launch by China

China launched four satellites for commercial remote-sensing services. The " Jilin-1" satellites, launched from the Jiuquan Satellite Launch Centre in China's Gansu province, include one optical remote-sensing satellite, two satellites for video imaging and another for imaging technique testing, Xinhua cited. *http://economictimes.indiatimes.com*

Setback for ISRO, Antrix to pay $672 million damages to Devas

In a jolt to ISRO's commercial arm, Antrix, an international tribunal has asked it to pay damages worth $672 million (Rs 4,432 crore) to city-based firm Devas Multimedia for "unlawfully" terminating a deal four years ago on grounds of national security.

The International Chamber of Commerce's(ICC) arbitration body International Court of Arbitration has ruled in our favour in the Antrix-Devas arbitration case and Antrix is liable to pay damages totalling $672 million to it, Devas said.

"Devas Multimedia and its shareholders, including highly-regarded international investors, are pleased that the ICC Tribunal unanimously ruled in its favor and found that Antrix is liable for unlawfully terminating the Devas-Antrix Agreement in February 2011," Devas said in the statement.

The Tribunal awarded damages and pre-award interest totalling USD 672 million to Devas with post-award interest accruing at 18 per cent per annum on that sum until the award is fully paid, it added.

The Tribunal comprising Michael Pryles, VV Veeder QC, and Justice AS Anand gave the order in an unanimous decision. It noted that Antrix had no legal justification for terminating the agreement and that Dr KR Radhakrishnan, who at the time of annulment, was Secretary, Department of Space and Chairman of ISRO, Antrix and the Space Commission, could have prevented the Cabinet Committee on Security(CCS) from approving the annulment.

The CCS had annulled the deal based on the recommendation of the Space Commission on the ground that it was not in the security interests of the country. Under the deal signed in 2005, Antrix was to provide 70 MHz of the scarce S-Band wavelength to Devas for its digital multimedia services by leasing 90 per cent of the transponders in ISRO's GSAT-6 and GSAT-6A satellites. Devas, in turn, was to pay Antrix a total of $300 million over 12 years. *www.ibnlive.com/*

Indonesia launches indigenous satellite

Indonesia launched its indigenous satellite codenamed Lapan A2, using rockets and launching pad in Satish Dhawan Space Center, India, highly expected as a milestone for Indonesia to master satellite technology, an Indonesian senior official said.

"The Lapan A2 was originally made by engineers and facilities of Lapan," Head of Indonesia's National Institute of Aeronautics and Space agency (Lapan) Thomas Djamaluddin said on the sidelines of witnessing live broadcast of the satellite launching in his office here.

In the future, he said that Indonesia is expected to be capable of producing rockets to support the satellite launching by itself. "So we can launch the satellite independently. We want to develop a satellite technology autonomously," Thomas added.

The satellite that weighs 78 kilograms, occupies an orbit lane around the earth's equator at an altitude of 650 kilometers from the earth's surface. The satellite would crisscross Indonesian territory 14 times per day with orbit period of 100 minutes, Thomas said.

According to Thomas, the satellite would be used to monitor the traffic of vessel, support the efforts to secure maritime security, exploration of fishery natural resources in the country. *Xinhua News Agency*

Formosat-5 slated for February 2016 launch

Taiwan's Formosat-5, an ultra-high-resolution Earth observation satellite operated by the Hsinchu City-headquartered National Space Organization, is scheduled for launch in February 2016, according to the NSPO.

With over 70 percent of the satellite having been developed domestically, Formosat-5 contains a locally made optical remote sensing payload, a Cassegrain telescope-type remote sensing instrument and the world's first complementary metal-oxide-semiconductor linear image sensor.

NSPO Director-General Chang Guey-shin said Oct. 15 that the satellite has passed space environment and function tests and is set to take over duties from Formosat-2, which has been in orbit since 2004.

According to Chang, Formosat-5 will be used for a diverse array of purposes in addition to academic research, following in the footsteps of its predecessors, which have proved instrumental in assisting disaster relief efforts while studying the impacts of climate change and global warming. *www.taiwantoday.tw/*

Kazakhstan mulls over joint space research projects with Belarus Society

Kazakhstan does not rule out the possibility of implementing joint space research programs with Belarus, Chairman of the Aerospace Committee of the Ministry for Investments and Development of Kazakhstan Erkin Shaymagambetov told media on 22 October, BelTA informs. "Joint projects is about timing. It is possible that we will launch a joint space research program of Kazakhstan and Belarus. I think it can happen," the head of the committee said. It is likely to take place in 2016," said Erkin Shaymagambetov. In his words, it is a framework document that will stipulate the main cooperation areas, including earth sensing, navigation, joint space research, personnel training. According to the head of the committee, the signing of the document will help intensify space cooperation between Belarus and Kazakhstan. *http://eng.belta.by/*

$1.9m civil penalty against aerial photography company

An October 6th Press Release from the FAA states that SkyPan International, a Chicago based aerial photography company conducted 65 unauthorized operations over a 2+ year period resulting in a $1.9M penalty. This is by far the most severe penalty the FAA has proposed, the previous leader being $18,700 against Xizmo Media which was issued in September. *http://hackaday.com*

NGA To Weigh Smallsat Options Under New Commercial Strategy

The U.S. National Geospatial-Intelligence Agency (NGA) could request funding as early as next year to begin experimenting with the different imagery products becoming available from a new generation of commercial satellite operators and data analytics firms.

According to a strategy document to be publicly released Oct. 26, the NGA envisions eventually entering into a variety of contracting schemes with the newcomers, many funded by Silicon Valley venture capital. Some of these companies have already begun launching imaging constellations of unprecedented size.

The initiative would not affect the NGA's current EnhancedView service contract with longtime supplier DigitalGlobe of Westminster, Colorado. But it suggests that DigitalGlobe, which over the past decade has swallowed up its peer-competitors, soon will have company as a provider to the mapmaking and imagery analysis agency, which buys commercial data on behalf of the military and intelligence community.

At nearly every public speaking engagement over the past year, NGA Director Robert Cardillo has discussed the "darkening of the skies" with small satellites and the possibilities this opens for an agency with ever-expanding imagery requirements.*http://spacenews.com/*

Russia to launch 2nd remote sensing satellite for Egypt: Energia

Egypt and Russia will sign a contract in late 2015 to establish a new Egyptian satellite for remote sensing, Vladimir Solntsev, head of Korolev Rocket and Space Corporation Energia, told Ria Novosti.

The satellite is planned to be launched in three years, Solntsev said. Egypt's first Earth remote sensing satellite EgyptSat-1, made in Ukraine, was launched in 2007, but Egypt prematurely lost contact with it in 2010. The country's second satellite, produced by Energia, was launched in April 2014. *http://thecairopost.youm7.com/*

Ozone Hole Approaches Record Size

Researchers from the German Aerospace Center (DLR) Earth Observation Center (EOC) used Earth-observation satellites to determine that the ozone hole over Antarctica currently extends more than 26 million square kilometers—an area larger than the North American continent. It's approximately 2.5 million square kilometers larger than at the same time in 2014, and just less than the record in 2006, when it was 27 million square kilometers.

Intense ozone depletion over Antarctica recurs annually, because the concentration of chlorofluorocarbons (CFCs) becomes enriched while low temperatures prevail during the southern hemisphere winter. Now in the southern hemisphere spring, additional sunlight causes these substances to exert their ozone-depleting effect. In recent years, the ozone hole appeared to have stabilised, suggesting a gradual recovery of the ozone layer. This year, however, the ozone hole formed one month later and now is almost as large as it was nine years ago. *http://eijournal.com/news*

Turkmenistan, Japan say joint UAV production perspective

The cooperation between Turkmenistan and Japan in building unmanned aerial vehicles (UAVs) is prospective, said the message from Turkmen government The project on building the UAVs can be implemented for creating 2D and 3D digital maps, defining the location of natural resources and for agricultural use. In this regard, training highly qualified local staff at the largest research centers in Japan, as well as exchange of experience in the sphere of nanotechnology and creation of highly profitable industries gains special importance.

"The rich positive experience of partnership in the sphere of science and education, alongside with the existing vast intellectual potential brings the cooperation between the two countries in this sphere to a new level," said the message.

Earlier, Ashgabat hosted an international scientific conference on innovative technologies in using renewable energy sources. The event focused on Turkmen-Japanese cooperation is developing innovative technology for getting silicon with high quality properties. *http://en.trend.az/*

U.S. Transportation Secretary announces Unmanned Aircraft registration requirement

U.S. Transportation Secretary Anthony Foxx and FAA Administrator Michael Huerta recently announced the creation of a task force to develop recommendations for a registration process for Unmanned Aircraft Systems (UAS). The task force will be composed of 25 to 30 diverse representatives from the UAS and manned aviation industries, the federal government, and other stakeholders. The group will advise the Department on which aircraft should be exempt from registration due to a low safety risk, including toys and certain other small UAS. The task force also will explore options for a streamlined system that would make registration less burdensome for commercial UAS operators. While the task force does its work, the FAA will continue its aggressive education and outreach efforts, including the "Know Before You Fly" campaign and "No Drone Zone" initiatives with the nation's busiest airports. The agency also will continue to take strong enforcement action against egregious violators.

More UAV surveillance needed following Nepalese earthquake

After the earthquake in April 2015, 15 UAV teams were deployed to Nepal to collect surveillance data and to carry out mapping work, but more still needs to be done in order to assess the true degree of the effects caused by the disaster.

A team from the Qatar Computing Research Institute's UAViators Humanitarian UAV Network has carried out work using rotary-wing UAVs such as the DJI Phantom. This included performing 60 flights in Kathmandu in September, authorised by the Civil Aviation Authority of Nepal.

In six months' time, the team is planning to also test some fixed-wing systems in Nepal. Patrick Meier, director of social innovation at the institute and founder of UAViators, is calling on more teams with a desire to help to join them. *www.flightglobal.com/*

New UAV for Malaysia

Malaysia has a new Unmanned Aerial Vehicle-Remote Sensing (UAV-RS) system to obtain information for monitoring natural disasters, resources management and land clearance. Science, Technology and Innovation Minister Datuk Wilfred Madius Tangau said the UAV-RS would improve the efficiency of obtaining information of the Earth's surface. "This RM3 million project was first researched in 2008 to then be developed in 2013 and fully operational by 2014. The system has now clocked a total of 180 hour 4 minutes flight time. "Developed by the Remote Sensing Malaysia Agency (ARSM), Multimedia University (MMU) and UST Sdn Bhd, the system is equipped with radar sensors, an optical sensor system and a ground control station," he said. He said the 185 kg drone could transfer data in real-time, has a service ceiling of 3 km within a 100 km radius for up to four hours. *www.nst.com.my*

GNSS & DGNSS tech expands SAILOR multi-function universe

SATCOM has launched two new SAILOR satellite navigation receivers. Both the SAILOR 656X GNSS and new SAILOR 657X DGNSS DGNSS are black-box products designed to be part of an innovative eco-system Cobham SATCOM refers to as its 'Multi-Function Universe'.

The advanced touch-screen SAILOR 6004 Control Panel forms the heart of the Multi-Function Universe, providing full control for all products connected to it from a single device. The SAILOR 656X GNSS and SAILOR 657X DGNSS join the already available SAILOR 6391 Navtex and SAILOR 628X AIS as new generation SAILOR products designed to work with the SAILOR 6004 Control Panel. *www.cobham.com*

NASA Awards Contract for Software, Maintenance to Esri

NASA has awarded a blanket purchase agreement (BPA) to Esri in Redlands, California, to provide geospatial software licenses and maintenance.

This BPA offers provisions for issuance of firm-fixed calls, with a one-year base ordering period, four one-year option ordering periods, and a potential contract value of $9.5 million. The contract will be administered by the Enterprise License Management Team at the NASA Shared Services Center (NSSC) at Stennis Space Center in Bay St. Louis, Mississippi. The NSSC performs select business activities for all NASA centers. *www.nssc.nasa.gov*

Satlab Geosolutions introduces SLD-100 Hydrographic Echo Sounder for GNSS Rover

Swedish based Survey and GIS equipment maker; Satlab Geosolutions AB, announces the availability of its SLD-100 GNSS Rover accessory to facilitate Hydrographic measurement in bodies of water up to 100 meters in depth. With survey grade accuracy, it can be added to any brand GNSS RTK Rover to allow for position and depth measurements to be made simultaneously. With a built in 10 hour lithium battery and transmitter unit with Bluetooth connectivity, the it provides standard depth data streams in several industry standard NMEA formats at 1Hz, 4800 bps, providing compatibility with any Hydrographic Surveying software package. *www.stalabgps.com*

PCTEL launches new high rejection GNSS antenna portfolio

PCTEL, Inc has launched its new GNSS multi-satellite antenna portfolio for mobile and base station timing applications. Its new SkyLink [™] antenna technology features unmatched out-of-band rejection characteristics, which provide GPS/Galileo and GLONASS L1 support and performance in heavy RF traffic environmentsfor fixed and mobile timing and asset tracking applications. The new portfolio consists of two product lines: SkyCompass™ for fleet management and asset tracking applications; and SkyStamp™base station antennas for timing and synchronization of 4G LTE cellular networks. *www.pctel.com*

Leica and Bentley team up for 3D photogrammetry

Leica Geosystems will incorporate Bentley Systems' *Acute3D* software to generate full 3D from photogrammetric surveys To be used for both UAV and piloted aircraft, users can now produce true 3D models that reflect the real-world context in mapping and infrastructure applications, directly from digital photography.

Leica Geosystems has selected *Acute3D* software to generate full 3D "reality mesh" representations from its airborne photogrammetric imagery. This combination of software and hardware advancements will enable users to take full advantage of integrated 3D surveying and mapping. Through reality modelling, observations of existing conditions are processed into representations for contextual alignment – for instance, within design modelling and construction modelling environments, in addition to mapping. Rather than generating a voluminous cloud of discrete points, *Acute3D* produces a 3D reality mesh, readily aligning the real-world context in mapping and infrastructure applications.

Topcon Announces DS-200i Connectivity with Autodesk BIM 360 Layout App

Topcon Positioning Group has announced its DS-200i direct-aiming motorized imaging station's compatibility with the new Autodesk BIM 360 Layout app for the Apple iPad. The DS-200i is the second total station solution that Autodesk and Topcon have collaborated on for contractors.

The DS-200i has an EDM (electronic distance measurement) range of up to 1000 meters (3280 ft.) without the need of a prism, and 5,000 meters (26,240 ft.) with one. The built-in wireless WLAN connects the iPad with the BIM 360 Layout app. The DS-200i features real-time video imaging with its 5 MP camera. The controller's touchscreen video and arrow keys are designed to let remote operators view what is being measured, similar to looking through the telescope.

Honeywell's Latest Navigation Technology for A320 and A330

Honeywell International Inc. has announced that its upgraded navigational technology will be available as an option on Airbus A320 and A330 aircraft in early 2018.

With the new Integrated Multi-Mode Receiver (IMMR), Airbus customers will gain access to the most modern precision navigation capabilities. The new navigation receiver will facilitate airline operators to leverage the most recent enhancements in satellite-based navigation. For example, they would be able to use Honeywell's SmartPath Ground-Based Augmentation System (GBAS), which enables more accurate approach and landing access than today's land-based systems. The new navigation receiver will also offer expanded capabilities for landing in very-low-visibility weather conditions.

Spectra Precision SP80 Wins Field Test Competition

The Agricultural Land Management and Statistic Department (ALMS) in Myanmar recently concluded comparative field tests of four leading models of GNSS receivers. The Spectra Precision SP80 swept to first in all tests. Based on the test results and bids, ALMS chose the SP80 and ordered 340 units. The comparative field tests included; positioning accuracy, initialization speed, internal radio performance, pole drop test, water immersion test to one meter, and on-board battery performance.

ALMS, under the Myanmar Ministry of Agriculture and Irrigation, has as its primary function land survey and map preparation in the maintenance of the nation's agricultural land registry.

According to Chan Htun Aung of Suntac Technologies, the Spectra Precision dealer for Myanmar, the SP80 performed better than the competition under all conditions, and it did especially well under tree canopy.

JAVAD GNSS TRE-3 Successfully Tracks First Live TMBOC Signal

Newly launched BeiDou Phase 3 satellites have several new signals. One is extremely similar to future GPS L1C signal with time-division BOC(1,1) and BOC(6,1) signals. Such type of modulation is called TMBOC. Using the same approach, as described in an article at gpsworld.com, the signal structure was decoded and L1C TMBOC tracking has been successfully tested on TRE-3 receiver.

In addition, new signals on 1575.42+1.023*14 MHz (B1-2), 1176.45 MHz (E5A) and 1207.14 (E5B) frequencies for three satellites (prn 32, 33, 34) have also been decoded and tested.

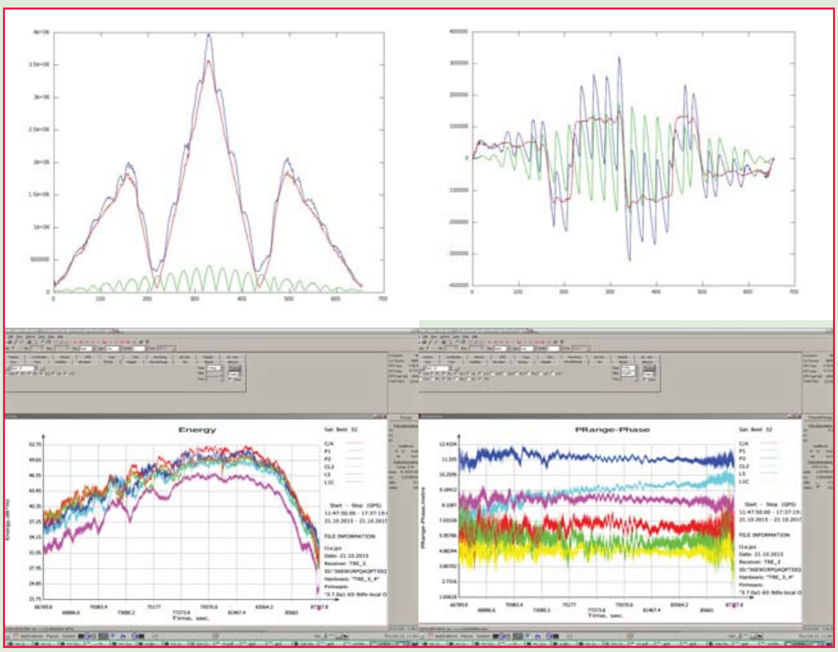
Some graphs, illustrating the experiment:

I of BOC(1,1) (red), BOC(6,1) (green) and their sum (blue) vs code shift.

dI of BOC(1,1) (red), BOC(6,1) (green) and their sum (blue) vs code shift.

Horizontal axis: 0 - munus one chip chift; 327 - zero shift; 655 - plus one chip shift C/NO and iono-free "range munus phase".

Slot - Beidou signal
C/A - B1
P1 - B1-2
P2 - E5B
L2C - B3
L5 - E5A
L1C - L1C



Esri and Trimble Offer the R1 GNSS Receiver to Enhance Field GIS Workflows

Esri has announced the availability of the Trimble R1 Global Navigation Satellite System (GNSS) receiver for collecting professional-grade GPS data with Collector for ArcGIS. The GNSS receiver is rugged certified MIL-STD-810, IP65 rated, compact, and lightweight and provides professional-grade positioning information to iOS, Android, or Windows mobile handhelds, smartphones, and tablets using Bluetooth connectivity for Bring Your Own Device (BYOD) capabilities.

Some users of Collector for ArcGIS on consumer-grade mobile devices might find their GPS to be less accurate than they need it to be. Now the locational precision of mobile devices can be enhanced via Bluetooth connected to the Trimble R1 GNSS receiver. The receiver is capable of supporting multiple global satellite constellation systems, including GPS, GLONASS, Galileo, and BeiDou, and delivers GNSS positions in real time without the need for postprocessing. *www.esri.com/news.*

Supergeo Cooperates with GNSS Solution Provider, CHC Navigation

Supergeo Technologies Inc., is now building a bridge with the fast-growing GNSS/GPS solution provider, CHC Navigation. SuperSurv, the mobile GIS product of SuperGIS, was selected as the value-added software that could be pre-installed for CHC users.

The combination of SuperSurv and CHC devices brings the possibility of getting sub-meter accuracy GIS data with reasonable costs. The result is the premier solution for researchers or workers that need to frequently work in the field. *www.chcnav.com/*

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November 2015

International Workshop on the Role of Land Professionals and SDI in Disaster Risk Reduction
25-27 November
Kathmandu Nepal
www.workshopnepal2015.com.np

December 2015

Esri India User Conference
2 - 4 December
New Delhi, India
http://www.esri.in/events

7th Multi-GNSS Asia (MGA) Conference
7 - 10 December
Brunei Darussalam
www.multignss.asia/workshop.html

The Geoinformation Technologies for Natural Hazards Management (7th GiT4NDM)
8 - 10 December
UAE University
http://conferences.uaeu.ac.ae/eogc-git4ndm/en/index.shtml

9th International Symposium on Mobile Mapping Technology (MMT 2015)
9 - 11 December
UNSW, Sydney, Australia
www.mmt2015.org

XXXV INCA International Conference
15- 17th December
New Delhi, India
www.inca35newdelhi.org/

January 2016

International Remote Sensing Conference
17 - 20 January
Saudi Arabia
www.irsc-sa.org

February 2016

EuroCOW 2016 Workshop
10 - 12 February
Lausanne,Switzerland
www.eurocow.org

March 2016

Munich Satellite Navigation Summit 2016
1 - 3 March
Munich, Germany
www.munich-satellite-navigation-summit.org

April 2016

IGRSM 2016
13 - 14 April 2016
Kuala Lumpur, Malaysia
http://www.igrsm.com/igrsm2016

May 2016

FIG Working Week 2016
2 - 6 May
Christchurch, New Zealand
www.fig.net/fig2016/call.htm

10th Annual RIN Baska GNSS Conference
8 - 10 May
Baska, Krk Island, Croatia
www.rin.org.uk

NAVITECH 2016
10 - 13 May
Moscow, Russia
www.navitech-expo.ru/en/

GEO Business 2016
24 - 25 May
London, UK
http://geobusinessshow.com

European Navigation Conference
30 May - 02 June
Helsinki, Finland
www.enc2015.eu

June 2016

HxGN LIVE
13 - 16 June
Anaheim,USA
http://hxgnlive.com/anaheim

6th International Conference on Cartography & GIS
13-17 June
Albena, Bulgaria
www.iccgis2016.cartography-gis.com

2016 Esri International User Conference
27 June to 1 July
San Diego, USA
www.esri.com

September 2016

ION GNSS+ 2016
12 - 16 September
Portland, Oregon USA
www.ion.org

October 2016

INTERGEO 2016
11 - 13 October
Hamberg, Germany
www.intergeo.de

ISPRS – PRAGUE 2016
12 - 19 July
Prague, Czech Republic
http://www.isprs2016-prague.com/

November 2016

Trimble Dimension 2016
7-9 November
Las Vegas, USA
http://www.trimbledimensions.com/

INC 2016: RIN International Navigation Conference
8 - 10 November
Glasgow, Scotland
http://www.rin.org.uk/Events/4131/INC16


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PENTAX
D-200
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H-1000C
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Positioning System
Precision satellite surveying, with wireless communications
W-800N
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