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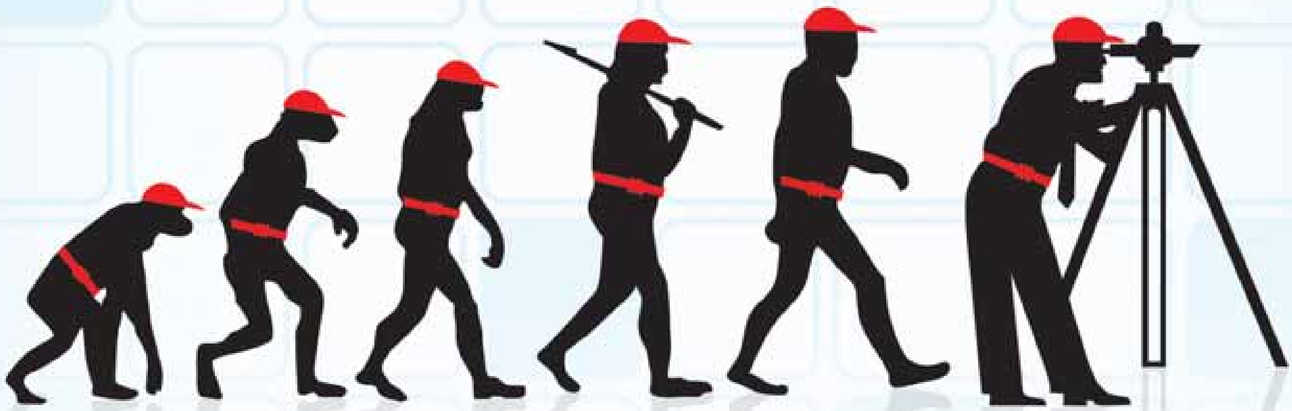
The evolving role of the surveyor



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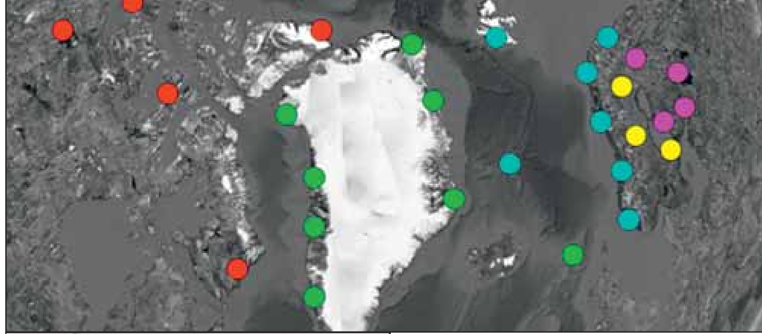

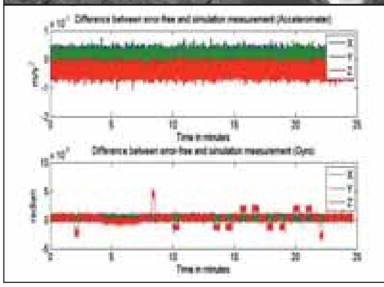

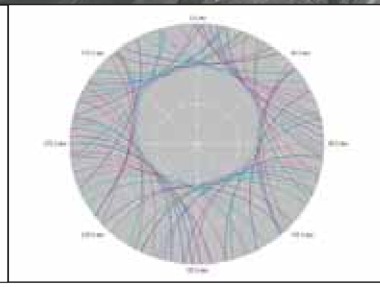

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Columns

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The role of surveyors needs to evolve.

From 'product orientation' to data analysts,

Quality control and quality assurance specialists.

The change has begun.

Adaptation is inevitable (read page 7).

Bal Krishna, Editor
bal@mycoordinates.org

Geospatial databases and the evolving role of the surveyor

The surveyor is being compelled to view survey measurements not in terms of products, but in the broader context of societal applications of the data

Frank Derby PhD
Associate Professor of Surveying and GIS
Bell Atlantic Center for Technology
The Pennsylvania State University, USA

With maturation of Geographic Information Systems (GIS) technology, the consumer community as well as decision and policy makers have quickly realized the importance of making sound decisions based on information derived from properly designed geospatial databases. Organizations have created proprietary geospatial databases and governments are rethinking the contents of the National Spatial Data Infrastructure (NSDI). Extensive geographic data acquisition programs including satellite imagery, digital aerial photographs and Light Detection and Ranging (LiDAR) systems at varying ground resolutions, as well as land parcel data are currently in progress around the world. Enabling technologies such as Global Positioning Systems (GPS) and digital image processing software have also facilitated the data processing aspects of these projects. The consuming public has also become more aware of the benefits of geospatial information, and is compelling service providers to provide it. Web-based applications are leading to data accessing and processing techniques such as "mash-ups" and cloud computing services through hosted content and virtual machines which process data from disparate locations.

In the early stages of the data capture and processing stages, the surveyor played a major role in the development of geospatial databases as well as the compilation of graphical data layers. In many of the developed world, a large portion of the traditional surveying aspects of the data capture have been completed. In view of these developments it is now time to look at the role that the land surveyor can play to improve the accuracy and integrity of the geospatial databases and applications, in order to ensure availability of better information to support policy and decision making as well as the needs of the consuming public.

Trends in geospatial data acquisition

Within the last thirty years, GIS technology has evolved from single purpose, project based applications to enterprise systems. Enterprise systems are currently being used by businesses, institutions, industry, local governments and the private sector to provide services to clients, manage resources, and to address multiple issues pertaining to health and human resources, transportation, public safety, utilities and communications, natural resource, defense and intelligence, retail and many more.

To support national development, governments are building national geospatial platforms as the infrastructure that integrates the NSDI to support research, policy matters, socio-economic development, to manage and allocate resources. The NSDI forms the framework that integrates spatial data, computer software, hardware, human resource and technology to meet geospatial data needs of local and municipal governments as well as organizations. In the United States, for example, the NSDI includes, transportation, elevation and bathymetry, hydrography, ortho-imagery, geodetic control, land parcel layers and administrative units. Local and municipal governments are compiling supplementary databases to support land development, taxation and revenue generation purposes, public safety, emergency management and other activities that are relevant to local and municipal governments. Utility companies are also developing databases for oil, gas, electricity, and water lines, together with descriptive data to help them become more efficient and responsive to customer needs. Development of geodatabases has evolved into an industry where commercial entities also produce and market proprietary geospatial databases in addition to providing geospatial applications in the form of services to consumers.

Whereas some of these data capture and compilation activities are conducted by traditional surveying methods, other data acquisition methods which involve extensive aerial photography, LIDAR and satellite imagery are conducted with limited involvement of surveyors. Terrestrial and air-borne GPS technologies have further reduced the need for traditional land surveying services. Mobile mapping technologies which are operated by companies such as Topcon and Trimble have also facilitated the data acquisition process, and further limited the activities of the traditional surveyor, by quickly providing 3-dimnesional georeferenced images of features within the camera range as the vehicle travels around a community. With increasing need for data acquisition, processing, and information dissemination, commercial companies have extended geospatial data acquisition to include marketing of proprietary databases, content hosting, and data analysis. The demand for geodatabases will certainly increase with increased societal needs.

Societal needs for spatially referenced information.

Proliferation of geospatial databases is enabling the geospatial industry to change the way decisions are made at the federal, state and local levels. Furthermore, geographic information technology has evolved into a ubiquitous mainstream consumer application. May readers are familiar with the humble beginnings of an application like Mapquest, one of the early geospatial technology applications. The success of this, and other applications, have resulted in other services from Navteq, TeleAtlas, Google, IBM, Microsoft, Apple and many more companies. As a result, consumers can now use applications such as Google Maps, Google Earth, Street View, in-car navigation systems with the ability to navigate to ATMs, specific restaurants, gas stations and be able to direct drivers to navigate detours around traffic congestions and highway constructions sites with ease. Members of the public who are geospatially aware and technology savvy are accessing Web GIS applications to enhance social networking experience through Facebook, Twitter, smart phones, the personal digital assistant (PDA), iPods and iPads. Such demand for geospatially enabled tools and applications have forced equipment manufacturers and service providers to think outside the box. They are responding to consumer requests through hardware improvement, hosted content, virtual machines, mash-ups and cloud computing. All these are possible because of geodatabases, geoprocessing tools and developers' ability to innovate.

Geodatabases maintained at research institutions, federal and local government repositories, commercial organizations, private a d utility companies, have made it easy for geospatial analysts to access data from a variety of sources for very small fees, if any. This has given geospatial analysts the opportunity to generate information through "mash-ups", whereby data from disparate repositories are analyzed online to generate information without having the data residing on the host computer. Computer networks consisting of platforms and infrastructure that host geospatial data content, software, processes, vision, and deployment models, all of which are maintained off premises are helping to extend the capabilities of the geospatial technology into cloud computing services. The networks within the cloud allow a user to access the technological capabilities of GIS to be delivered on demand to the end user through the Internet.

Whereas all these applications and innovations are extending the value of information, it is important though, to note that the quality of information depends to a large extent on the quality of the data and the processes through which they have been put in order to derive that information. In this regard, availability is not as important as accuracy, currency, completeness, fitness of use, and resolution. All these qualities of data may have different levels of importance in a particular application. For example, the casual user who wishes to see an aerial view of his neighborhood does not really care if his house is not in the correct geographic location. Many users of location-based applications have, at least on one occasion, been presented with aerial maps with an arrow pointing to the wrong house. Others have been presented with old images in which major constructions or features are missing. However, very few, if any, have been put off by such "simple" mistake in the application. With so many types of spatial data at different scales and accuracies, the need to maintain data quality, integrity and correspondence is presenting new opportunities for surveyors. Indeed, it is extending the services of the surveyor beyond product-oriented services.

The emerging role of the surveyor

Prior to the geospatial technology, the surveyor's services mostly resulted in products such as topographic, subdivision, and other maps. In recent years, the primary roles of the surveyor within the geospatial technology industry have been to capture and process data for inclusion into the spatial database. There have been few cases where a surveying company has had to develop the geodatabase too. However, today's geospatial technology places less emphasis on products but rather processes, knowledge infrastructure, capacity building, communication and coordination. The value of the information is based not on the ability to share data or products but the knowledge to assess data quality and to determine their fitness-of use in order to ensure the quality of the information. The surveyor is being compelled to view survey measurements not in terms of products, but in the broader context of societal applications of the data.

With the availability of geospatial data in various formats, from different sources, and having varying lineage, accuracy, currency, and suitability for a defined application, the need to use the right kind of data for the right application is becoming even more important. Granted that metadata standards require that the legend of digital geospatial data which shows the source, original scale, purpose, accuracy, and processes through which the data has been put be provided, it still remains the responsibility of the user to ensure its suitability for a defined application.

Issues with accuracy, resolution, and currency, exist even with aerial photographs, LiDAR, and satellite images too. Although aerial photographs can be processed by simply georeferencing them to known ground coordinates, the quality of the resultant images are different from ortho-rectified images which have been corrected for variation in topography, imperfections in the camera, and aircraft attitude at the instant that each photograph was taken. Although many pieces of spatial data may have associated time stamp, accuracy specifications and other parameters that will assist a knowledgeable person to assess their usefulness, the surveyor's expertise and training qualifies him in as the best professional to assess the quality and reliability of the ground controls and hence, the accuracy of the processed image.

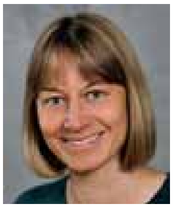
Furthermore, geospatial technology allows users to perform analysis and investigate phenomena in large geographic regions. The ability to work in large geographic areas implies that it is no longer correct to maintain the flat view of the earth, which used to be the case for small geographic areas. The science of geodesy and map projections which are used to process and present data with respect to the curved earth's surface is becoming important in geospatial technology applications. The importance of geodesy has now become extremely important not only for those who capture and process spatial data, but to content providers and analysts as well. It is necessary to ensure that a Web-based application service provider has used the correct spatial reference system and that the results have been presented in the correct map projection system also.

Through their training, surveyors are equipped to understand these subject matters and have been able to incorporate them into their products for many years. Geodatabase technology is now requiring surveyors to apply their expert knowledge to assess the quality of the data before they are used in applications. In effect, surveyors are now becoming data analysts and quality control and assurance experts in the world of geospatial technology. This transformation will be facilitated if surveyors would refrain from seeing their services as product-oriented and begin marketing themselves as data analysts as well as quality control and quality assurance specialists to geospatial technology industry.

Adaptation is inevitable. To capitalize on these emerging opportunities, it is necessary that surveying educational institutions adapt by modifying surveying programs and placing more emphasis on data analysis, geodesy, map projections, quality assessment, and geodatabase development and management. The change has already begun. Some surveying institutions are already preparing the new generation of surveyors for these emerging opportunities but the transformation is rather slow.

Challenges for positioning and navigation in the Arctic

The paper focusses on the limitations of GNSS in the Arctic, followed by some potential solutions and suggestions for further research



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Consultant

The Arctic ice is receding at a faster pace than expected a few years ago, and is quickly opening for increased human activities beyond the Arctic Circle (66.56° N). This drives a growing demand for navigation in the Arctic area, which is mainly composed of marine expanses and the land masses of Norway, Iceland, Greenland (Denmark), Northern Canada, Alaska (USA), and the Northern parts of Russia.

Marine navigation is expected to increase as both the North-West and North-East passages from the North Atlantic to the West coast of the Americas and to Asia respectively become ice free larger parts of the year. Tourism activity is also expected to expand, with more cruise ships visiting the area as well as a growing use of the sea routes for general transportation of goods and people to and from the cities and settlements in the area. Fishing and hydrographic survey vessels will investigate the new and partly uncharted areas left open by the ice retreat.

Also, as a consequence of the withdrawing ice, the oil and gas sector has an increasing interest in the Arctic, as large and so far mostly un-explored resources are known to be present in the area. The growing activities of the off-shore industry will not only raise the demand for marine transportation, but also traffic with helicopters and small airplanes is expected to rise as more people and material need to be transported between airports, treatment plants on land, and off-shore installations.

Unfortunately, several adverse factors impede safe and accurate positioning in the Arctic. In particular, GNSS-based positioning and navigation face a number of limitations that cannot be easily overcome. This includes the ionospheric effects on satellite signals which in the Arctic are highly affected by an increased electron precipitation causes higher ionospheric variability reducing GNSS performance.

Satellite communications and satellite based augmentation systems for GNSS (SBAS) are also significantly affected by a reduced performance in the Arctic, because the geostationary satellites are visible at very low elevation angles, and in the most Northern parts of the area, the reception of signals from geostationary satellites is not possible at all. This means that positioning and navigation using satellite based augmentation such as the European EGNOS and the American WAAS is generally not feasible in the Arctic. The European Space Agency is aware of this and has just launched an Arctic Testbed project with the purpose of testing measures for improved GNSS navigation in the arctic.

At present, ground based augmentation systems such as the IALA DGPS beacons are not a solution because of the very poor and in most places missing infrastructure of these systems.

Other factors causing reduced safety in the area are the rough weather, the drifting sea ice and ice bergs, the remoteness of the area, poor maps and charts, lower accuracy of magnetic and gyro- compasses etc. All of these problems make positioning and navigation in the area difficult.

This paper aims at raising the awareness about these issues and foster thoughts on finding ways round them. We will focus the discussion on the limitations of GNSS in the Arctic, followed by some potential solutions and suggestions for further research.

Challenges for GNSS in the Arctic

For GNSS, presently GPS and Glonass but in the future also for Galileo, the performance in the Arctic region is reduced compared to the performance obtained by users at mid latitudes. The reasons are mainly the satellite-receiver geometry and the ionospheric effects on the satellite signals, but also users do not have the benefits of satellite based augmentation systems (SBAS) at a larger scale. These three effects are discussed in the following:

Infrastructure for SBAS

For the SBAS systems GPS correction data is transmitted to navigation users via geostationary satellites (GEO). These satellites are located in the geostationary orbit at the Equator and the satellites are thus visible very low on the horizon at high latitudes. SBAS data reception is therefore often noisy and unreliable, and north of 81º N the satellites are not visible at all.

In cases when GEO signals are received at high latitudes the performance of SBAS is reduced compared to lower latitudes. The main reasons for this are the limitations in the ionosphere modeling which is discussed below, but also the large distances between reference stations in the remote Arctic region. After two new EGNOS reference stations (RIMS stations) were established at high latitudes in Norway in 2008, an improvement in EGNOS availability of almost 30 percentage points per day was found for parts of the Norwegian Sea (Jensen et al., 2009). This indicates how the density of the ground based GNSS stations directly affects SBAS performance.

Also, satellite based communications suffer by the same limitations caused by ionospheric activity as satellite based positioning and navigation. In situations with increased ionospheric activity where ionospheric SBAS corrections really are needed for the EGNOS or WAAS user, the transmission of corrections might be disrupted by ionospheric perturbations.

GNSS satellite geometry

For GPS satellites the inclination angle is 55º and for Galileo the planned inclination angle is 56º. This means in practice that no satellites signals are received in the zenith direction north of the corresponding latitudes (i.e. north of 55º and 56º N). If the GNSS receiver is located further north, the elevation angles of the satellites is reduced as the latitude increases.

This can be illustrated by skyplots showing the 24-hour satellite tracks for a given position. Figure 1 provides a skyplot of the GPS satellites for Copenhagen in Denmark at 56° N and for Longyearbyen on Svalbard (Norway) at 78° N. The color coding in the plots indicate the tracks of different GPS satellites.

The consequence of this is better horizontal satellite geometry, but worse vertical satellite geometry compared to the situation at mid and low latitudes. In other words, the HDOP is better and the VDOP is worse for high latitudes. This does directly affect the accuracy of the height in a position solution. But also the horizontal position accuracy is in many cases reduced because there is a higher noise level in the observations, caused by the large number of more noisy low elevation satellite signals. The low elevation of the satellites further worsens the ionospheric effect.

For Glonass the inclination angle is 65º and this does provide slightly better conditions for use of this GNSS at high latitudes.

Ionospheric effect on satellites signals

The ionospheric effect is mainly driven by the solar activity and thus follows the 11-year solar cycle with a currently rising activity and an expected high during 2013-2014.

In the Arctic the ionosphere is further characterized by an enhanced electron precipitation causing higher ionospheric variability and large gradients of TEC. The aurora is a visible illustration of the enhanced electron precipitation.

An example of the ionospheric variability is provided by El-Arini et al. (2009) with GPS data from Thule in Northern Greenland. Results show TEC varying with more than double the background values in less than 10 – 15 minutes, as well as very rapid short term variations in TEC.

Another example is provided by Jensen et al. (2008) with GPS data from

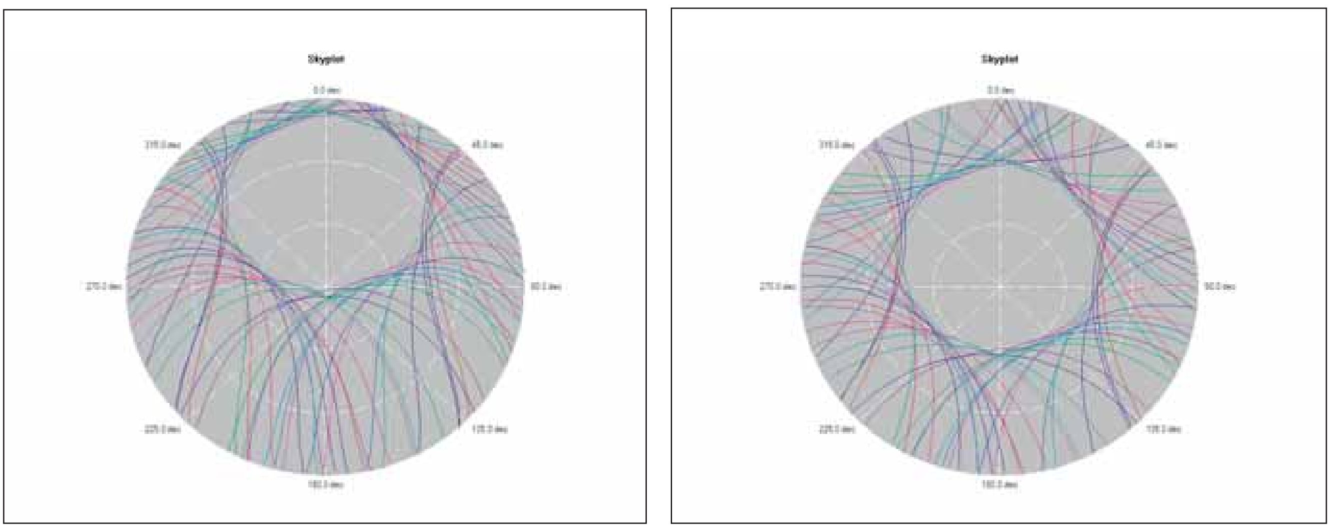


Fig 1. Skyplots of GPS satellite constellation for Copenhagen at 56° N (left) and for Longyearbyen at 78° N (right). Plots generated with Leica Geo Office software.

Norway and the ionospheric I95 index, which indicates the level of ionospheric variability by estimation of gradients. Here the I95 index is up to five times larger for GPS data collected around 70º N than for data collected at around 60º N during the same epochs in time.

In the positioning algorithms of GNSS navigation receivers the ionospheric effect is normally handled by ionospheric models. But these models are generally insufficient to compensate for the ionospheric effect in the presence of large TEC gradients (Coster et al., 2003).

This is often the case in the Arctic and the consequences for GNSS users with navigation grade receivers is a poor positioning performance with very large errors in the position solution.

For high accuracy positioning and navigation the use of ionospheric models is combined with the ionosphere free linear combinations of observations from the GNSS frequencies in order to minimize the ionospheric effect to a level where carrier phase ambiguity resolution is possible. Higher order ionospheric effects are, however, not handled by the linear combinations.

Second and third order residual errors of 10 cm or more will thus be present in the observations (Morton et al, 2009). In case of large TEC gradients it is difficult, sometimes impossible, to successfully resolve the ambiguities because of the large residual ionospheric effects.

Another effect of the ionosphere is scintillation. This is caused by small irregularities in TEC which induce changes in signal phase or amplitude. Scintillation events in the Arctic are generally correlated with auroral activity, large TEC gradients, and geomagnetic storms. Scintillation causes GNSS receivers to loose lock on the satellite signals, limiting positioning and navigation capabilities.

Scintillation events in the Arctic have been characterized e.g. by Skone et al. (2008). They found that in cases where GNSS receivers were affected by scintillation in Northern Canada, electron density irregularities present in the ionosphere were spanning a very large range in altitude, from about 100 to 300 km above the ground based GNSS receivers.

Many of the present GNSS users in the Arctic region, especially in Norway and Greenland, operate in the area of the auroral oval or just south of the auroral oval, and here GNSS performance is also affected by the ionospheric trough (also called the 'main trough'), a region with depleted ionization located just south of the auroral oval (Hunsucker and Hargreaves, 2003).

GNSS signals passing through the trough are affected by the TEC gradients and users in this area are thus further exposed to scintillation as well as to limitations in the ionosphere models and problems with ambiguity resolution.

Suggestions for solutions

Considering the growing activity in the Arctic, the problems with the present navigational means, and the consequences of accidents it seems very important to focus more R&D resources on improving navigation systems in the Arctic.

One of the potential solutions already on its way is multiple frequencies for GPS and Galileo. More frequencies provide more data in the positioning algorithms, and this does in general improve performance. Also more frequencies provide better means for handling the ionospheric effect, because more combinations of observations of the various frequencies can be generated.

However, higher order effects of the ionosphere are difficult to remove even with more frequencies, and the problems with the low elevation satellites and the scintillation effects are not solved by transmitting on more frequencies in the L-band.

Another obvious solution which is already available to some extent is the use of inertial navigation systems (INS) combined with GNSS. The inertial sensors are integrated with GNSS to bridge the navigation solution during scintillation gaps and help mitigate the effect of large unexpected TEC gradients. At high latitude, INS suffers from poorer heading accuracy, because the earth rotation rate vector measured by conventional gyroscopes is almost vertical.

This makes the users more dependent on GNSS for heading measurements. Given the short duration of scintillation events, though, this would not be an issue for most of them. INS may also support autonomous integrity against fast variations of TEC.

In order to obtain solutions which will last longer and provide more reliability to Arctic positioning and navigation, new and improved methods for ionospheric time/spatial variability models must be developed.

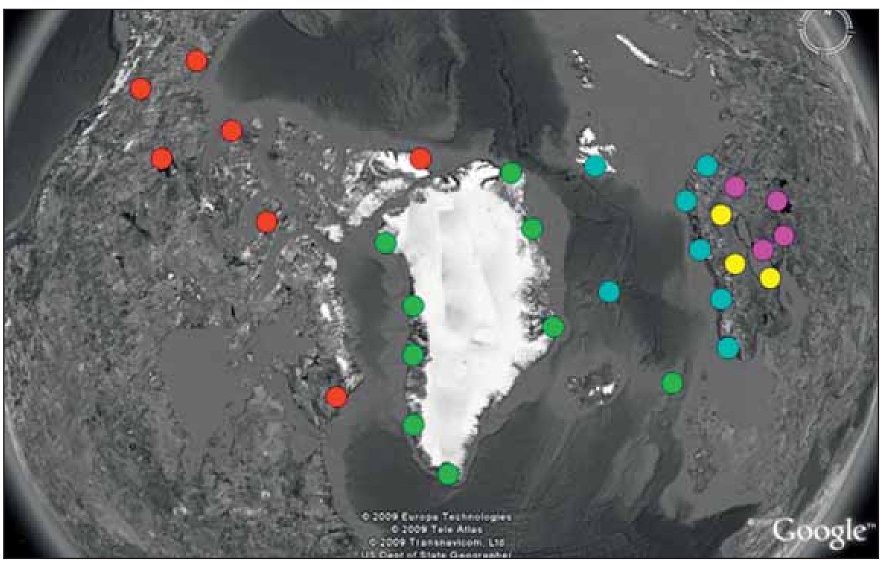


Fig 2. Arctic GNSS Stations operated by national agencies in Canada (red), Denmark (green), Norway (cyan), Sweden (yellow) and Finland (magenta)

Basically, more knowledge of the ionospheric activity in the Arctic is needed by the scientific community in order to develop better and more robust models for this region. Figure 2 illustrates the location of 30 high grade geodetic type GNSS stations in the Arctic operated by National agencies. It is recommended to acquire data from a denser observation network, both in order to monitor and better map the ionospheric activity in the Arctic, but also to better feed real time ionosphere models and predictions for improved performance. Benefitting from the seasonal feature of the activity in the Arctic, most navigation needs appearing during summer, it may also be considered to use temporary and expandable (e.g. air-dropped) observation stations, or data collected from mobile stations (vessels).

One aspect is the ability to monitor the propagation of traveling ionosphere disturbances which will to some extent enable predictions of TEC gradients with a denser network of GNSS stations. This could form the basis for a GNSS based ionospheric warning system in the Arctic.

Using a combination of various types of observations of the ionosphere for instance GNSS data, magnetometer data, and radar can also lead to improved ionosphere models by the use of advanced data fusion methods.

For distribution of GNSS augmentation data in the Arctic the use of the MEO constellation of navigation satellites (i.e. the GNSS satellites themselves) must be investigated, for instance the planned MRS channel of Galileo. This does indeed seem like the best long term solution, but with the present Galileo design, there is a limited capacity of the MRS channel and the bandwidth is too narrow for broadcasting enhanced SBAS corrections.

Long endurance UAVs (unmanned aerial vehicles) could be another solution. These could be positioned over the region of interest, and data could be communicated and relayed from the most remote regions into regions with adequate communication infrastructure.

The advantage of the UAVs is that these can be moved and placed where the need for reliable navigation is highest. Alternatively, aerostatic stations such as e.g. the NASA's Ultra Long Duration Balloon used in Antarctica might be considered for periods up to a few months.Also the use of low frequency (LF) radio waves should be investigated. The Arctic region is covered by LF radio which is presently used for instance for communication with vessels in remote areas. Use of LF channels for dissemination of GNSS augmentation data does however also require further investigations on data structures, messages types etc.

A consequence of increased human activities in the Arctic is the foreseeable demand for improved communication capabilities. Therefore a dedicated constellation of satellites might be considered, using highly elliptical orbits (e.g. Molniya or Tundra), which would take care of GNSS augmentation data broadcast as well as many other communication needs. It is noteworthy that highly elliptical orbits have been selected by Japan for QZSS, and such satellites would also be much appreciated from GNSS users in urban environments at moderate northern latitudes, where geostationary satellites signals are too often masked.

Conclusion

If an accident does happen in the Arctic the consequences can be serious. The remoteness, the large distances, and the rough weather cause difficulties for search and rescue (SAR) operations as the nearest airstrip is often very far away. Also the Arctic environment is vulnerable and very slow in regeneration after for instance an oil spill, so an accident could initiate an environmental disaster.

There is a need for improved systems for positioning and navigation in the Arctic soon. Most professionals will not wait to roam the Arctic area, and the authors of this paper therefore encourage more focus on research and development for improved navigation systems in the Arctic.

Acknowledgements

The authors would like to thank Dr. Per Knudsen, Danish National Space Institute, for providing the map in Figure 2.

References

Coster, A., Foster, J., Erickson, P. (2003). Monitoring the Ionosphere with GPS. GPS World. May 2003.

El-Arini, M.B., Secan, J., Klobuchar, J.A., Doherty, P.H., Bishop, G., Groves, K. (2009). Ionospheric effects on GPS signals in the Arctic region using early GPS data from Thule, Greenland. Radio Science. Vol. 44, 2009.

Hunsucker, R.D. and Hargreaves, J.K. (2003). The High-Latitude Ionosphere and its Effects on Radio Propagation. Cambridge University Press. 2003.

Jensen, A.B.O., Grinde, G., Hanssen, R.I. (2008). System for Performance Monitoring with Respect to Ionospheric Activity at High Latitudes. Proceedings of the European Navigation Conference, Toulouse, France. ENC – 2008.

Jensen, A.B.O., Hanssen, R.I., Mikkelsen, A., de Mateo, J. (2009). EGNOS Performance in Northern Latitudes. Proceedings of the 13th IAIN World Congress, Stockholm, 27-30 October 2009. Published by the Nordic Institute of Navigation.

Morton, Y.T., van Graas, F., Zhou, Q., Herdtner, J. (2009). Assessment of the Higher Order Ionosphere Error on Position Solutions. Navigation, Journal of the Institute of Navigation, Vol 56, no. 3, Fall 2009

Skone, S., Man, F., Ghafoori, F., Tiwari, R. (2008). Investigation of Scintillation Characteristics for High Latitude Phenomena. Proceedings of the 21th International Technical Meeting of the Satellite Division of the Institute of Navigation – ION GNSS 2008.

An interview with

Charles Branch

Portfolio Manager
Radio products
Pacific Crest Corporation

"Radio and positioning solutions from Pacific Crest go hand-in-hand"

"The Gold Standard in Communications and Positioning." What are the efforts that go into maintaining the 'standard' at Pacific Crest?

The efforts are towards:

- Increasing range by use of cleaner signal and greater receiver sensitivity
- Increasing operational efficiency by use of smarter protocols
- Increasing throughput by use of new data compression technologies
- Increasing reliability by making each radio bullet proof.

And they are bulletproof, though we do not recommend testing this in populated areas. Actually we do not recommend testing this at all.

Also, dragging the radio behind a truck is not recommended. The radio in the picture needed to have a new toggle switch put on it but it wasn't otherwise damaged. We just put the internals inside a new housing and shipped it back.

Please elaborate on your 'Radio modems' portfolio for our readers?

The PDL Line going end of life: PDL RXO, PDL LPB, PDL HPB, EDL II, Sitecom, PDL Rover

The PDL line is being replaced with ADL line which include:

- OEM modems: ADL RXO and ADL Foundation, and a variety of custom built radio modems designed and manufactured for our OEM customers.

- Complete radios: ADL Vantage and ADL Sentry – transceivers with 0.1 to 4 Watt configurable output, rugged all metal IP67 housings and an extensive list of accessories from data interface cables to antennas and power supplies.

Would it be correct to say that radio and positioning solutions from Pacific Crest go hand-in-hand?

Yes, because our positioning solutions are "precise positioning" solutions, i.e., with cm-level accuracy. The only way to do this in real-time is by providing the rover GNSS receivers with Real Time Kinematic corrections. Using a cable is obviously not possible so wireless communication must be an integral part of the overall solution. Each GNSS receiver board we sell to system integrators must be attached to a radio. We strive to ship one radio modem for each GNSS receiver we sell.

What are the difficulties that 'wireless data communication using radio frequency' face in the real world?

There are several issues:

- Crowded airwaves.
- People stepping on each others frequencies.
- Interference from consumer wireless products.
- Cannot get licenses or do not want to go to the trouble of acquiring them and paying for them.
- Cellular coverage is poor in most areas of the world.
- It is fine for voice in Europe, Japan, and much of China and the US, but not as capable of handling data transmissions.
- Also, in high density areas at peak load times, you can get data/voice dropout.
- Different brands of radios do not talk to each other. This is

ok as long as the radios support the standard Pacific Crest protocols, but radios that don't/won't support PCC protocols (or do so with errors) frustrate their users.

How do Pacific Crest products overcome these difficulties?

Last year we began releasing the ADL generation of UHF radios that support software-derived channel bandwidths. As governmental regulatory agencies such as the FCC and ETSI require the use of 12.5 kHz channels in place of the more bandwidth-consuming 25 kHz bands, ADL customers can make the switch just by uploading a new channel table. And when countries start requiring 6.25 kHz channels, Pacific Crest will be ready to meet the challenge.

Pacific Crest has also worked with other radio manufacturers to support each other's protocols so customers have greater flexibility when building on to their radio networks.

Among the various 'Precise Positioning' and 'Remote Sensing' solutions offered by Pacific Crest which ones require the most customization?

The radio boards we sell to system integrators require the most customization because different customers want different:

- Antenna connectors
- Data connectors
- Types of serial data, e.g., CMOS or RS232
- Different power input: some solutions give only 3 V, some want to give the board 3-7 V, etc.
- Custom protocols and modulations
- Custom sizes

Which regions do you think will see the maximum growth in the wireless data communication segment in the coming months?

- Technology: Cellular links, WiFi links, networked radios
- Applications: Precision agriculture, offshore positioning, environmental monitoring of industrial sites
  - Markets: China (huge growth that is beginning to explode at a somewhat slower rate); India (slow growth at present but huge potential in the future), US and Europe remain slow but are growing again and will soon face large infrastructure replacement needs.

Pacific Crest: The Gold Standard in Communications and Positioning

Pacific Crest is the leading supplier of wireless data communication solutions designed for positioning and remote sensing applications. Pacific Crest was acquired by Trimble Navigation in 2004 and is also responsible for the sale and support of Trimble's high-accuracy GNSS board sets to the OEM and system integrator market.

Pacific Crest was founded in 1994, with the mission of developing DGPS technology for precision survey and agricultural applications. Today Pacific Crest serves a broad cross-section of major markets with its rugged and reliable radio and positioning solutions. These markets are broken down into two discrete application segments: precise positioning and remote sensing.

"Pacific Crest enables customers to build a solution that reduces the size, cost, and complexity of critical data communications and positioning systems. Customers require the highest performance, reliability and support for their positioning solutions. We believe we have an innovative line of digital radios tailored to deliver new levels of quality, reliability and flexibility for data communications in the geomatics industry."

John Cameron
General Manager, Pacific Crest

Precise positioning applications include land/marine surveying, construction and machine control, agriculture, and infrastructure monitoring. These applications utilize both Global Navigation Satellite Systems (GNSS) technology and the radio links that communicate Real-Time Kinematic (RTK) corrections from GNSS reference stations to GNSS rover receivers.

Remote Sensing applications include environmental monitoring, water management, and pipeline/transmission line management. These applications require the broadcast of digital information from remote sensing devices to central offices that process the data for decision making as well as send command/control instruction back to the remote sensors.

Positioning Solutions: Pacific Crest offers Trimble's latest centimeter-level positioning technology to system integrators. GPS/GNSS receiver modules harness the widest range of GPS L1/L2/L5, GLONASS L1/L2, and Galileo experimental signals in easy-to-integrate modules that provides fast RTK initialization with proven low-elevation tracking.

Radio Solutions: Radio modems from Pacific Crest provide wireless data links for RTK positioning and remote sensing. Pacific Crest is the leading provider of high-performance data links for the Geomatics industry based on the acceptance of its communications protocols as the standard for RTK surveying.

Marketing of maps imagery and other geospatial data in India

A plea for additional objective for NSDI

P Misra
Consultant, Land Information Technologies

There is no denying of a characteristic that marketing as a concept and priority do not go hand-in-hand with the good departments. Survey of India, National Remote Sensing Centre, Geological Survey of India, Forest Survey of India, National Bureau of Soil Surveys and Land Use Planning (NBSS & LUP) and many other member-organization of NSDI are no exception. As a matter of interest, if you try to know what all is available in India from the portals of NSDI and other organizations, you are hardly rewarded by the desired information.

NRSC is comparatively better organized for marketing but procedures for demand requires prior knowledge and, therefore, needs hand-holding to a large extent.

The organization which deal with the generation of geo-spatial data have not allocated the right priority to the marketing function with regard to their data products and services. So much so that first stage of marketing - making customers aware of the products and services has been done perfunctorily. There is, naturally, big scope for improvement. All data producing organizations are clubbed as service organization of the Government of India. Surely, they all will improve their image and acceptability markedly, if the supply of data is done with due regards to the marketing principles. NSDI should, in due course, earn the label of 'professional' in the marketing function.

Need / Function	Scale	Height/ contour interval (mts)	Remarks
Planning: Master Plan/ Structure plan, Zoning plan	1:4000 to 1:5000	2 to 5 mts	Legal document
Engineering Plans	1:2000 to 1:4000	0.5 meters/ 2M Bench Marks	Frequent revision
Housing Plans	1:1000 to 1:4000	Do -	
Water Supply, Sewerage	1:1000 to 1:2000	Spot heights + Bench Marks	
Traffic Junction Plans	1:1000 to 1:2000		
Transportation Routes	1:5000 to 1:10000	2 mts	
Road & Highways	1:2000 to 1:10000	I m	
Regulatory Functions			
Revenue Authorities	1:1000 to 1:4000	-	Checking encroachments, property matters
Unauthorised construction, encroachment, squatter settlement, monitoring	1:2000 to 1:4000		
Other departments			
• Ground water • Drainage • Inventory of trees, parks, environmental themes • Heritage Monuments • Police/ Fire • Tourists	1:10000 to 1:25000 1:10000 to 1:25000 1:4000 to 1:10000 1:1000 1:2000 1:10000 to 1:20000		

Table 1 User-Needs-Products

Ambit of marketing of data-products

The objective inherent in the title of this paper is not only going to be influenced by all the traditional principles of marketing, namely, 4 Ps (Product, Price, Place, Promotion) (Refer to box1) but also by the additional strategic Ps. These are Preparation, Potential (of technology) and Publications including publicity as part of Promotion. All these marketing functions will greatly help in reaching the super-objectives of NSDI. In fact, the marketing principles as mentioned here have guided the thrust of the ideas/suggestions and pleas mentioned in the ensuing paragraphs.

What is written here in is also applicable to all the member – organizations. These may decide to meaningfully extend their organizations through effective marketing. NSDI is well poised to provide marketing advise and common platform for promotion and publicity.

If is said that 'marketing' is the real business the rest is all overhead. If is rather difficult to stretch this definition when data products and services are being undertaken by government and semi-government organizations. Nevertheless, the importance of marketing functions cannot be undervalued or ignored.

P-for product (s) and market segmentation

In the marketing sense products are

SMART RADIO FAMILY. AND IT'S GROWING.

[ADVANCED DATA LINK : THE NEW STANDARD]

ADL Foundation | ADL Vantage | ADL Sentry | ADL RXO

Now, the world's most Advanced Data Link technology is available in one very smart family.

- 40 MHz Bandwidth Range
- High Over-the-Air Link Rate
- Configurable Transmit Power Up to 4 Watts
- Software-Derived Channel Bandwidth
- Easy to Integrate Radio Modems

One smart family, and a whole new standard in wireless communications.

PACIFIC CREST
A TRIMBLE COMPANY

For more info: www.PacificCrest.com/ADL

evolved and designed continuously keeping the demands of the users in view. In other words, the market-domain of the products is 'segmented' into different categories of the users. For example, the type of map required by a tourist is going to be different than, say, an engineer. While a tourist is mostly concerned with the terrain features and ease in their interpretation, an engineer on the other hand requires the finer details and map should be accurate enough for his design and measurement. Extending the example to the satellite imagery, one may have to provide imagery of required specifications to:

- Geography/Land Information based Academic Interest Groups e.g. Universities.
- Professional users e.g. consulting firms, government agencies, NGOs and other enthusiastic users of the imagery.
- Research groups-technology enlightened users - Scientists of NRSC and equivalent in institutions, dealing with modeling and monitoring projects.

Users Require different products

In our case of GIS oriented activities, the requirements of the various users can be easily converted to :

- Scale (s)
- Main specification of the product – digital or analogue
- Mode of preparation and dispatch of data
- Other topics e.g. projection, etc.
- Governing policies of Government of India e.g Restriction Policy

NSDI- proposed nodal agency for marketing

The chapter "Future episodes" of book "NSDI in India- Through the years" published by Coordinates has suggested some objectives which should be added to the charter of NSDI. One glaring omission appears to be the marketing of data-products and services. It is in this context that the following suggestions are being made.

Strong website / Portal

These days all students and professionals turn to the portal of the organization to get the relevant information about products services. Besides, the portal contains links to the various sources of information. Portals should, therefore, be designed keeping marketing in view. Additionally, a brief description of the technology could be furnished in the form of 'tutorials'.

(4+2) Ps of Marketing

P-Product, includes service etc.
P-Price of the Product or Service
P-Place- Availability of Product or Service timely supply
P-Promotion, including awareness, publicity, etc.

Strategic Ps

P- Planning for Marketing, Total domain of users
P-Post-Marketing feedback from customers and users for newer products.

Short training courses arranged by NSDI

These short courses – may be of one or two days duration- are extremely effective in generating:

- awareness of the various Land Information Technologies (LIT). LITs could be demonstrated through completed projects or workshops.
- Show –case capability of the various organizations associated with the NSDI regarding research projects availability and use of the latest equipment and other cutting edge of the technology
- Users-forum for exchange of ideas on the technology.

It is quite natural that NSDI will choose the organization and its premise for the above tasks. What will impress the data and service domain will, of course, be the holistic benefit of the data-products and push the use of GIS in India.

For example, professionals from cadastral discipline and geography will be able to see convincingly the BIG picture of the GIS technology in India. All these activities help in replication of the technology is their setup.

Comprehensive mailing list

This mailing list should have the addresses of all likely users of the spatial data. The addresses with the Department of Space (National Remote Sensing Centre) user in connection with their magazine INTERFACE will be very useful. Similarly, mailing lists with other professional societies e.g. Remote Sensing Society and others can be incorporated.

It has already been established that regular information on data and services have brought revenue and tangible projects in the real world of business.

Incidentally, quoting one Consulting Firm of Delhi, it says:

"We are prepared to place a permanent order on all the outputs regarding spatial data is case somebody gives timely information. Such statements are eye-openers for marketing strategy. NSDI can easily this challenge and take advantage of the situation.

In simple business/financial terms it means that all your future products are deemed to have been sold thereby earning revenue to the organization.

An extension of the above idea may mean 4 to 5 times production and distribution of maps (and digital data) without much hassle.

Enhancing awareness about data products and services

On the face of it, the above activity seems to be quite simple and easy to implement. Yet in 90% cases, the users, who are not laymen but are professional in their own disciplines do not know about the data. In authors' experience these professional/consultants are prepared to spend substantial amount if the data/information is already available. Otherwise, they have to generate the data ab-initio. They have money but no time.

In such a scenario, if some agency helps them to procure data, they will be grateful.

The upshot of all what is written is that responsibility of informing and generating awareness should remain with the data generations. NSDI can be very effective in this enormously important but neglected area (awareness)!

May I suggest, that resorting to advertisement in national newspapers, magazines and on the web will be quite in order- and will be appreciated by one and all.

Let us not be miserly in spreading good information.

Concept of NSDI Associate/Partner

Any one, individual or organization, who can enhance the professional and marketing objectives of NSDI and / or its constituents can be termed as NSDI-Associate. Similarly, Partner will be those individual (s) or organization (s) who enhance the objectives of NSDI in a big (measurable in terms of transactions) way can be called NSDI Partners. To explain further, Partners are professional persons/organization who understand the complete working of NSDI, powers and limitations of spatial – data sets, services and should be capable of providing consultancy regarding suitability, availability and checking of data sets and services of/ by NSDI.

(To be taken as guide lines)

The Associate/Partners are expected to act as Facilitators Par Excellence in the domain of NSDI. On the operational side, the following points will gain importance.

All those individuals who attend and qualify for short courses of NSDI will get a Certificate of Associate ship.

All those individuals / organizations who help in marketing of services and spatial data, say, to the extent of Rs 50,000 or more could be named as Partners of NSDI and should be given a certificate.

Extending the concept of enhancement of marketing. more and more recruitment of Partners should be taken to further the objective of effective marketing for NSDI and its members.

Timely service / supply- An experience

It is my early experience of 1960s. Survey of India was commissioned to produce large scale irrigation-project maps on a large size, called Quad-Demy.

On my visit to the Project office at Jammu, I enquired out of curiosity for learning, how the maps are being actually used by the engineers.

Hesitatingly, one engineer – supervisor of the draftsmen took me to a big hall. But I didn't see the maps. On enquiry he told me that the office is using the maps but the reverse-blank-side of the maps! Why?

The maps were delivered 8 months late. The project authorities had finished their project.

A few selected Partners could increase their business / organization turnover by participating in Public Private Participation (PPP) Projects. These may pertain to revision surveys, maintenance of Bench Marks or similar operations of NSDI members.

Some more points of interest for marketing

Difference between 'customer' and the 'user'

When a father buys chocolate for his son, he is the customer and his son is the user. Therefore, product/ service should primarily be designed/ improved from the point of view of the user.

New Products/Maps

New maps (Paper and digital) which users may like to have.

Map+imagery

Users will like to have the satellite imagery printed on the reverse of the line-map.

The line map provides quick interpretation where as the imagery could be used for thematic (geology, forestry/vegetation, soil, etc.) interpretation. For larger scale maps ie larger scales than 1:10,000 users will prefer superimposition or separate printing of aerial photograph (if possible!)

Revision of maps

Users should see more frequent cycle of revision of maps as proposed below:

Urban maps- 2 to 5 Years because of frequent changes.Sami – urban- 5 to 7 years
Rural maps- 5 to 10 years
cadastral maps
Maps pertaining to highway corridors (national and state highways) -2 to 5 years
Tourist areas-2 to 5 years.

Integrated thematic information on 1:50,000 scale (geology, soil, vegetation, ground water, etc)

Some laudable attempts have been made by the Department of Space in their NRIS (National) (Natural) Resources information system (NRIS). Thematic information: for 22 layers of spatial information and 8 layers of non-spatial attributes. (Reference-Publication of Department of Space)

NRSI is a GIS based national level asset to have thematic digital information suitable for the density required for 1:50,000.

The research oriented specifications of NRIS (and other equivalent information systems of Department of Science

Appendix A
Government of India
Ministry of Rural Development
Notice Inviting 'Expression Of Interest'
Implementation of PURA (Provision of Urban Amenities in Rural Areas)

Scheme in PPP Framework
The objectives of the PURA scheme are provision of livelihood opportunities and urban amenities in rural areas to bridge the rural-urban divide.The scheme envisages holistic and accelerated development of areas around a potential growth centre in a Gram Panchayat (or group of Gram Panchayats)in a Public Private Partnership (PPP) framework. Ministry of Rural Development (with support from Department of Economic Affairs and technical assistance of Asian Development Bank) intends to implement the PURA scheme on a pilot basis under a PPP framework.

Scope
The scope of the scheme would be to develop livelihood opportunities, urban amenities and infrastructure facilities to prescribed service levels and to be responsible for maintenance of the same for a period of ten years. The selected private partner would be required to provide amenities like water supply and sewerage, roads, drainage, solid waste management, street lighting telecom electricity development in a panchayat/ or a cluster of panchayats as part of the PURA project. The selected private partner may also provide 'add-on' revenue-earning facilities such as village linked tourism, integrated rural hub, rural markets, agri-common services centre and warehousing any other rural-economy based project etc in addition to the above mentioned amenities.

Financing model
The leveraging of public funds with private capital and management expertise for creation and maintenance of rural infrastructure is the essence of the PURA scheme. The scheme envisages convergence of funding from various ongoing schemes of Central Government, private financing and capital grant wherever required.

Bidding process
Ministry of Rural Development (MoRD) invites expressions of interest (eols) in sealed envelope from private sector entities having experience in development / construction and management of community – oriented infrastructure projects either as a single entity or as a consortium who meet following qualification criteria.

i. A minimum net worth of Rs.25 crore
ii. Experience of developing infrastructure projects having a cumulative value of at least Rs.50 crore

Guidelines of the PURA scheme may be downloaded from *www.rural.nic.in*

& Technology, Department of Space NRSC, etc) should be so massaged so as to bring a user friendly digital or paper product is the domain of marketing / sales to the public at large.

National Remote Sensing Centre has produced excellent 1:50,000 maps on the various themes along with Action Report. Many districts of India have already been covered. Similar reports and maps are available under NRDMS project.

All such reports and maps should be offered for sale offer carrying due publicity and promotion.

Town maps on 1:25000 scale – compiled map

The whole of India is covered by 1:25000 Survey of India maps. These maps could be collated to form a composite town map of a city. These will be useful to the public as height information and other topographical features will be depicted on the town map.

Highway corridor maps on scale of 1:25000

These maps will be quite popular with car-travelers. Here again, these maps could be generated from existing 1:25000 maps. Naturally, revision of these maps will form an important activity by the production organization.

Thematic maps on 1:50,000- from L.I.T organization

Presently maps/data are being produced by Geological Survey of India, National Bureau of Soil Surveys and Land Use Planning, Central Ground Water Board and Forest Survey of India.

These organization could be advised to produce digital version of spatial data suitable for publishing paper copy on 1:50,000 scale.

GIS activities in India will increasingly demand 1:50,000 and larger scale maps.

Revision surveys as public-private participation (PPP) mode

The revision surveys (see separate paper by the author) should be under taken as PPP project ministry of rural development (Reference appendix A.)

PURA should be fully involved in rural areas, highway corridors and semi-urban areas for revision of map-data.

Presently, the revision of surveys/ map is one survey function which is woefully out of date for all types of the maps in India. Unless, we adopt some innovative methods, maps will perpetually be out of date.

Concluding thoughts on marketing

Marketing is not a difficult operation. It only needs priority in scheme of management and simple operating procedures. The moment, we think of service, we should think of 'users' (as a group of satisfied persons).

It will immediately lead to the design of new products (maps and digital data) and of course 'delivery system'.

As mentioned, make a beginning (with the existing products) on the awareness front. Organizations, I am sure will be overwhelmed by the joy of satisfying people on a large scale.

Society will legitimize the existence of data producing agencies, only if it gets serviced well.

Three New Revolutionary Products

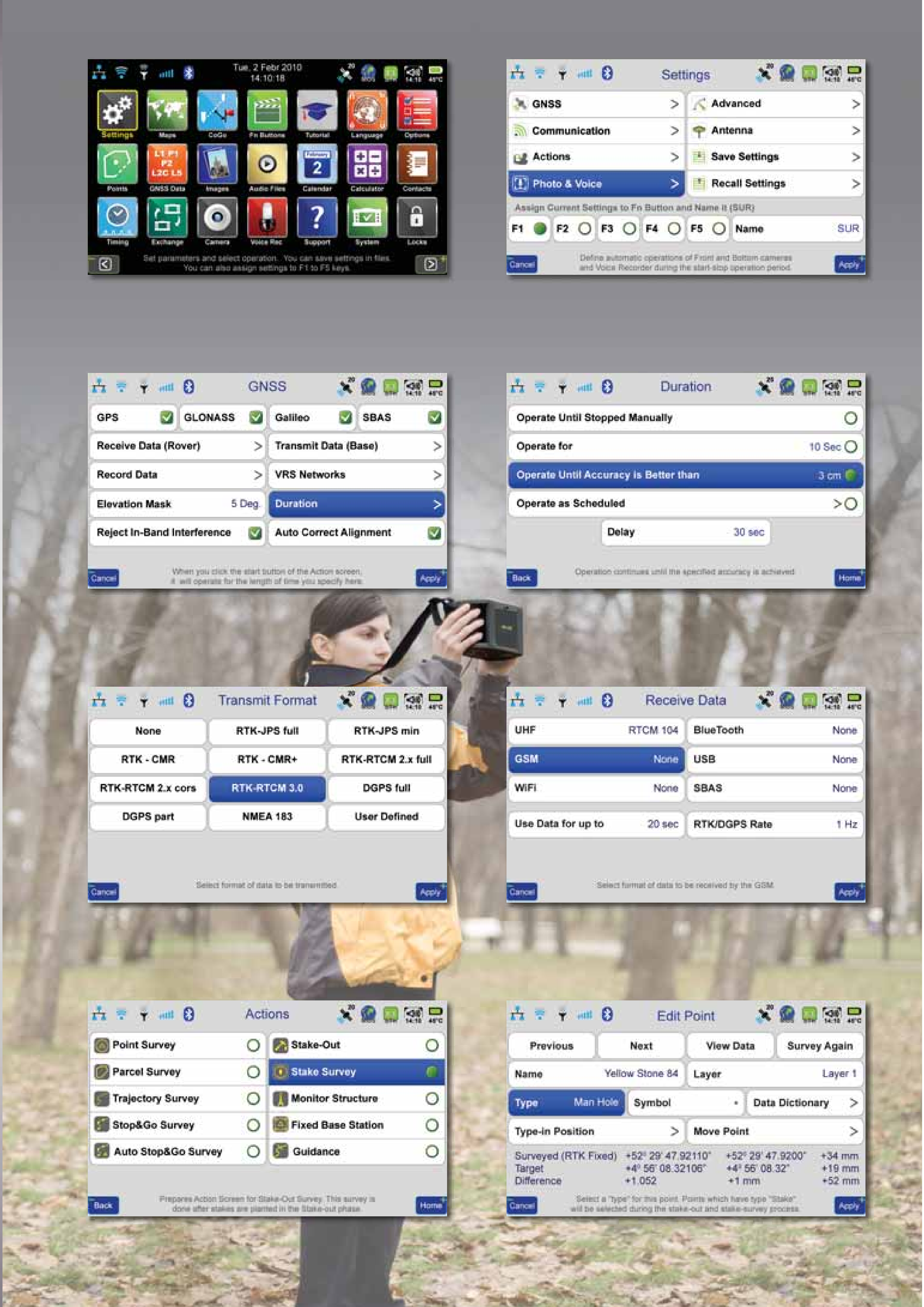
1

High precision all-frequencies GNSS Antenna
GPS+GLONASS+Galileo

Revolutionary, compact,
216-channel GNSS Receiver

2

External Power
USB
USB
Ethernet



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Calculator
Contacts
Timing
Exchange
Camera
Voice Rec
Support
System
Locks
Set parameters and select operation. You can save settings in files.
You can also assign settings to F1 to F5 keys.
Settings
GNSS
Advanced
Communication
Antenna
Actions
Save Settings
Photo & Voice
Recall Settings
Assign Current Settings to Fn Button and Name it (SUR)
F1
F2
F3
F4
F5
Name
SUR
Cancel
Define automatic operations of Front and Bottom cameras
and Voice Recorder during the start-stop operation period.
Apply
GNSS
GPS
GLONASS
Galileo
SBAS
Receive Data (Rover)
Transmit Data (Base)
Record Data
VRS Networks
Elevation Mask
5 Deg.
Duration
Reject In-Band Interference
Auto Correct Alignment
Cancel
When you click the start button of the Action screen,
it will operate for the length of time you specify here.
Apply
Duration
Operate Until Stopped Manually
Operate for
10 Sec
Operate Until Accuracy is Better than
3 cm
Operate as Scheduled
Delay
30 sec
Back
Operation continues until the specified accuracy is achieved.
Home
Transmit Format
None
RTK-JPS full
RTK-JPS min
RTK - CMR
RTK - CMR+
RTK-RTCM 2.x full
RTK-RTCM 2.x cors
RTK-RTCM 3.0
DGPS full
DGPS part
NMEA 183
User Defined
Cancel
Select format of data to be transmitted.
Apply
Receive Data
UHF
RTCM 104
BlueTooth
None
GSM
None
USB
None
WiFi
None
SBAS
None
Use Data for up to
20 sec
RTK/DGPS Rate
1 Hz
Cancel
Select format of data to be received by the GSM.
Apply
Actions
Point Survey
Stake-Out
Parcel Survey
Stake Survey
Trajectory Survey
Monitor Structure
Stop&Go Survey
Fixed Base Station
Auto Stop&Go Survey
Guidance
Back
Prepares Action Screen for Stake-Out Survey. This survey is
done after stakes are planted in the Stake-out phase.
Home
Edit Point
Previous
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Survey Again
Name
Yellow Stone 84
Layer
Layer 1
Type
Man Hole
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Data Dictionary
Type-in Position
Move Point
Surveyed (RTK Fixed) +52° 29' 47.92110" +4° 56' 08.32106" +1.052
Target +52° 29' 47.9200" +4° 56' 08.32" +1 mm
Difference +34 mm +19 mm +52 mm
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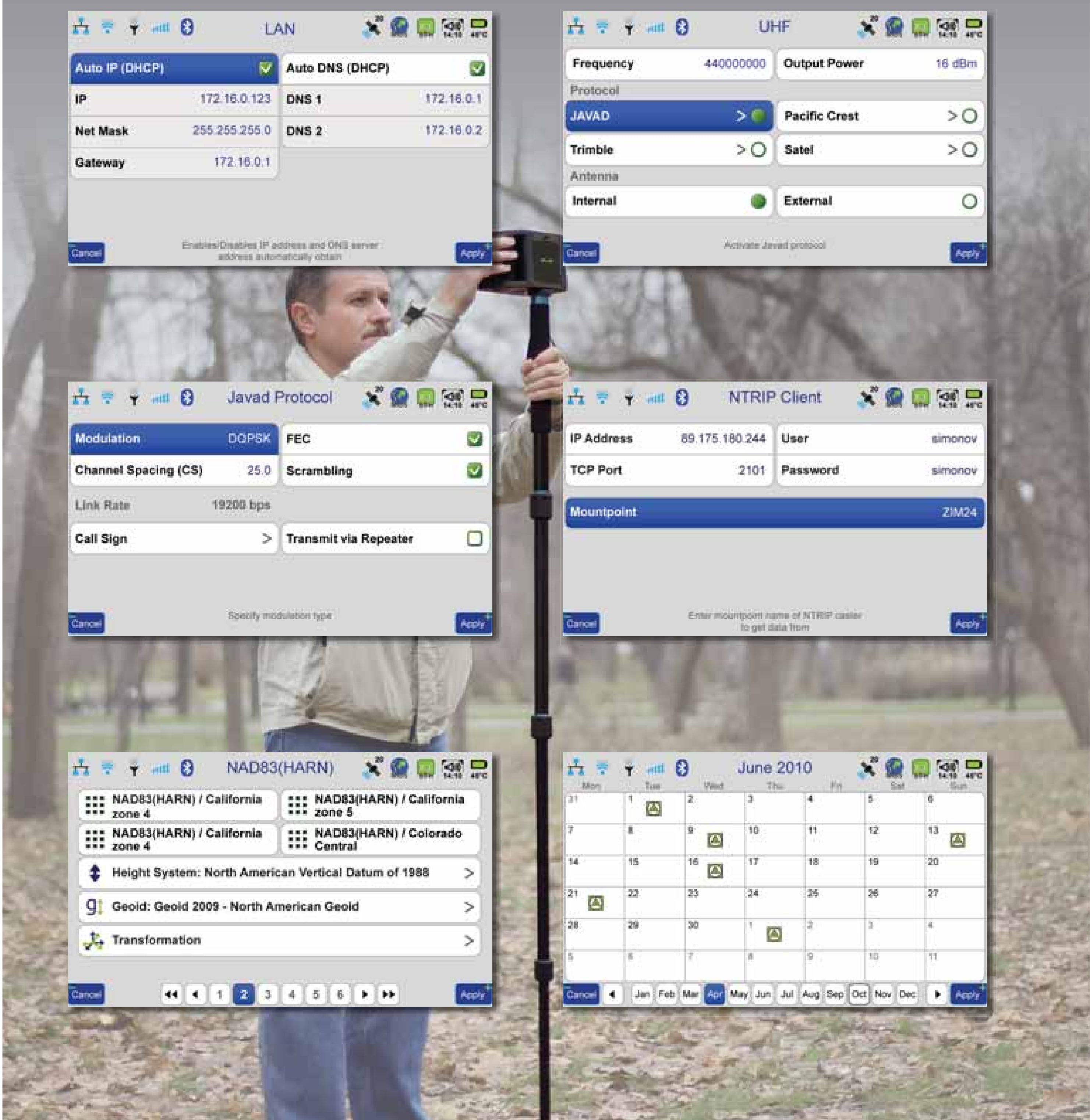
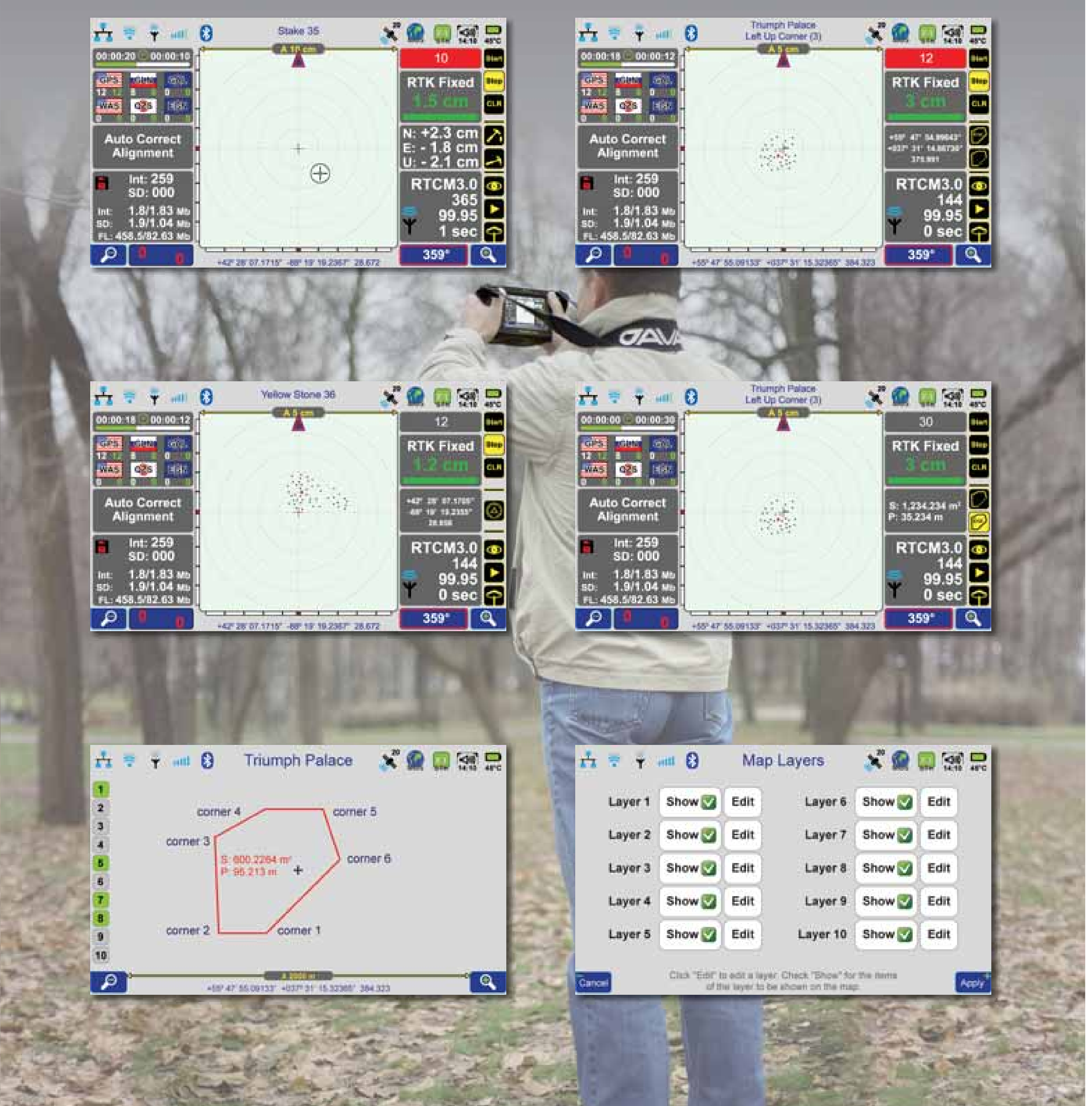
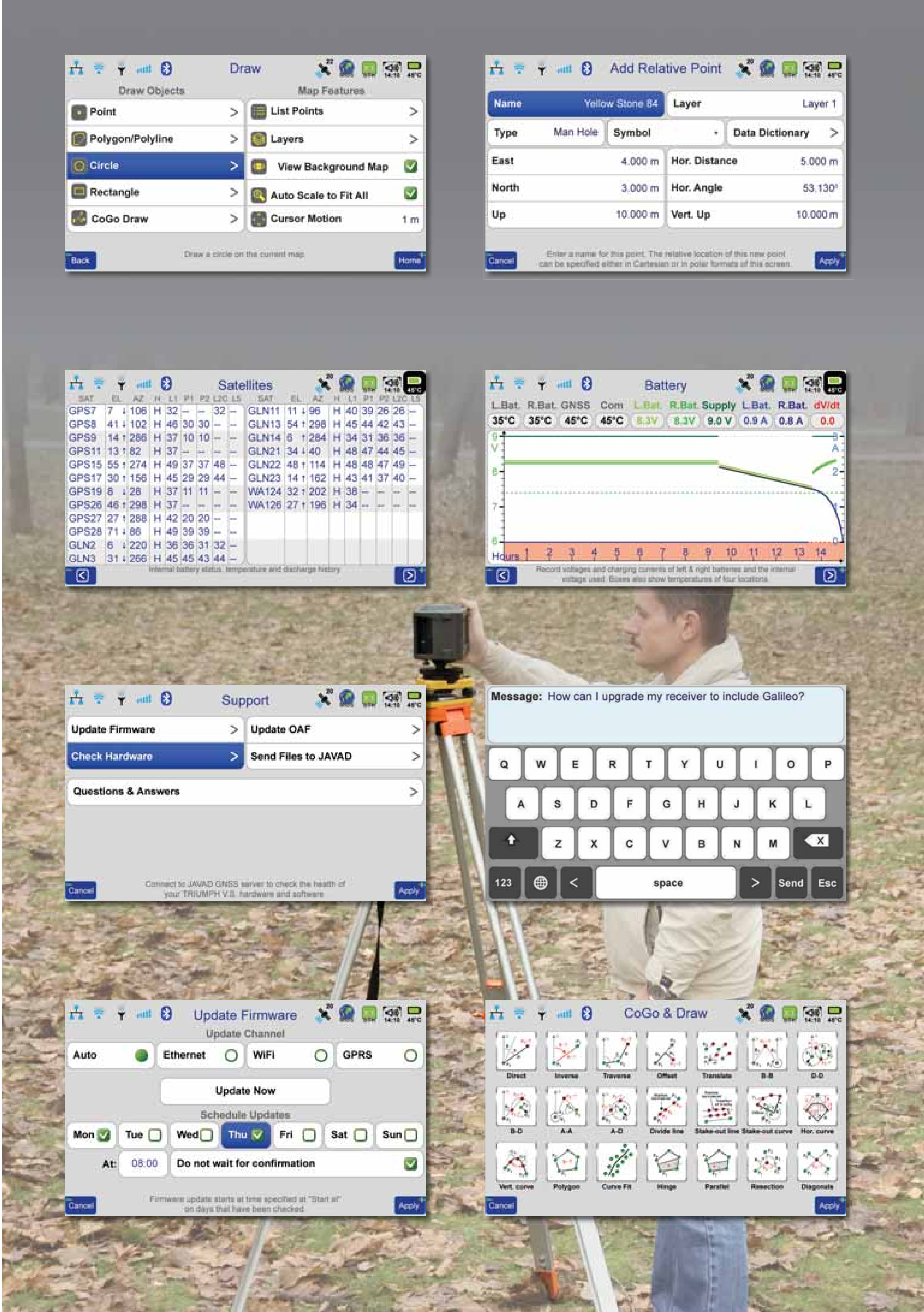
Select a "type" for this point. Points which have type "Stake"
will be selected during the stake-out and stake-survey process.
Apply

Let the Screens...



Speak for themselves

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Rectangle
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Layers
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Draw a circle on the current map
Home
Add Relative Point
Name Yellow Stone 84
Layer Layer 1
Type Man Hole
Symbol
Data Dictionary
East 4.000 m
North 3.000 m
Up 10.000 m
Hor. Distance 5.000 m
Hor. Angle 53.130°
Vert. Up 10.000 m
Cancel
Enter a name for this point. The relative location of this new point can be specified either in Cartesian or in polar formats of this screen.
Apply
Satellites
Internal battery status, temperature and discharge history
Battery
L.Bat. R.Bat. GNSS Com L.Bat. R.Bat. Supply L.Bat. R.Bat. dV/dt
35°C 35°C 45°C 45°C 8.3V 8.3V 9.0 V 0.9 A 0.8 A 0.0
Hours
Record voltages and charging currents of left & right batteries and the internal voltage used. Boxes also show temperatures of four locations.
Support
Update Firmware
Check Hardware
Questions & Answers
Update OAF
Send Files to JAVAD
Cancel
Connect to JAVAD GNSS server to check the health of your TRIUMPH VS hardware and software
Apply
Message: How can I upgrade my receiver to include Galileo?
space
Send
Esc
Update Firmware
Update Channel
Auto
Ethernet
WiFi
GPRS
Update Now
Schedule Updates
Mon Tue Wed Thu Fri Sat Sun
At: 08:00
Do not wait for confirmation
Cancel
Firmware update starts at time specified at "Start at" on days that have been checked
Apply
CoGo & Draw
Direct
Inverse
Traverse
Offset
Translate
B-B
D-D
B-D
A-A
A-D
Divide line
Stake-out line
Stake-out curve
Hor. curve
Vert. curve
Polygon
Curve Fit
Hinge
Parallel
Resection
Diagonals
Cancel
Apply

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"Our focus will be on meeting user needs"

says Swarna Subba Rao, Surveyor General of India about the upcoming agenda for Survey of India

As the Surveyor General of India what are your immediate priorities for Survey of India?

Survey of India is India's National Survey and Mapping Organisation and is the oldest scientific department of the country. In the years since its establishment in 1767 it has developed a rich tradition and legacy of mapping. It is also a very large organisation which has not only grown but also evolved over the years.

But the entire dynamics of the geospatial industry has changed in the last few years due to the rapid developments in technology and the changing user needs. For Survey of India to be in tune with this changing scenario there is a need to restructure the organisation.

We have some of the most qualified and dedicated professionals with us, but we need to re-orient the people, infuse the latest IT and re-design some of the technical aspects towards meeting the evolving needs of the users.

What do you think Survey of India needs to do to meet the varied requirements of the growing number of spatial data users in the country?

First of all we need to understand the changing requirements of the various users. Today the customers look for softcopy data in formats which are compatible for their specific needs. In many instances the data has to be GIS ready.

Survey of India is known for its quality products, but earlier all our products were used to be in hard copy format. Then we started providing data in softcopy format. Now we need to focus on providing data to users in the formats required by them and user friendly.

Besides the routine maps like the toposheets, we would try to meet all the geospatial data needs of the users;, be it from the government, academia or private in a timely and efficient manner.

Mapping and technology are inseparable today. How do you see this relationship developing in Survey of India?

I would like to see Survey of India adopt IT in it's core activities. Information Technology is a very important aspect for us as an organisation. For an effective administration as well as to meet the current geospatial data requirements we must make ourselves IT competent.

Where does Survey of India stand as a 'brand' today?

With its long history and legacy, Survey of India is already a well established brand in the geospatial domain. However, there is a definite need to revive this brand and re-establish our identity as a leading geospatial data provider.

Public-Private-Partnership (PPP) as a model of operation has got a fillip in India in the recent past. Do you think Survey of India can also capitalize on this concept?

The total geospatial needs of the country cannot be met by Survey of India alone. We will need to go into partnership, but will have to work out the modalities as per the rules and regulations of the government.

We would definitely like to explore avenues where we can work together with the industry to enhance the geospatial data availability for the users. We may also need to outsource some work depending on the evolving needs.

What is role of Survey of India in programs such as the National Land Resource Management Programme (NLRMP) and National Urban Information System (NUIS)?

We are very much part of these programs. Survey of India is actively involved in both the NLRMP and NUIS. In case of the NLRMP, The Indian Institute of Surveying and Mapping (IISM) has been imparting training to State revenue and land records department officials to meet their needs for modern technology in computerization of land records. For NUIS we will be completing the mapping in the next few months.

Do you think maps and the survey profession get adequate attention in the education system in India?

There is a lack of awareness about maps and their importance in general. I think the educational institutions can play a crucial role in creating an interest in and awareness about maps among the students. When the interest and awareness increases there will automatically be more interest in map making and surveying.

There is also a definite need for capacity building at the higher levels. I would like to add that the IISM is playing and important role towards this capacity building and has a tie up with Jawaharlal Nehru Technological University (JNTU), Hyderabad for certain courses.

Survey of India and National Spatial Data Infrastructure (NSDI) - please comment?

NSDI is a great initiative to meet the spatial data requirements of the various users in the country. Considerable progress has been made by NSDI in the last decade. But what NSDI is trying to achieve takes time and the challenge is to engage more and more organisations in the process. Survey of India has supported and will continue to support the NSDI initiative. There is synergy in the goals of both Survey of India and NSDI - to make geospatial data available to users. We look forward to working with the various NSDI partners in taking NSDI towards its goal.

Where do you see Survey of India in 2015?

Here I would like to re-emphasise the vision of Survey of India today, which is to 'take a leadership role in providing user focused, cost effective, reliable and quality geospatial data, information and intelligence for meeting the needs of national security, sustainable national development, and new information markets.' I hope that in the next five years this vision and chosen mandate of Survey of India will be visible in letter and spirit.

The implementation a simulation platform for INS/GNSS integrated systems

We publish this paper in two parts. We present here the components of INS/GNSS simulation plateform and principle of the simulator. Results and discussion will be published in Nov 2010 issue.

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Global Positioning System (GPS) provides precise timing, position, and velocity information by utilizing the constellation of satellites and a remote receiver that uses range measurements to the satellites and spatial trilateration techniques. In addition, more navigation satellite systems including Russia's GLONASS, Europe's Galileo, and PRC's Compass will be available for the coming years. Those systems will form the mainframe of future Global Navigation Satellite System (GNSS).

GNSS receivers require direct line of sight signals to the GNSS satellite to provide solutions with long-term stability; consequently, it is capable of providing continuous navigation solutions with uninterrupted signal reception (El-Sheimy, 2004). However, GNSS leaves two scenarios to be considered in the land environment. The first one is intermittent signal reception, as for instance in heavily forested areas or in urban centers. The other one is no signal reception at all, as for instance in buildings, tunnel or underground. In the first case, GNSS has to be integrated with other sensors to bridge periods of no signal reception. In the second case, GNSS has to be replaced by another navigation system that can provide continuous navigation solutions in above environments during no GNSS signal reception (Chiang, 2004).

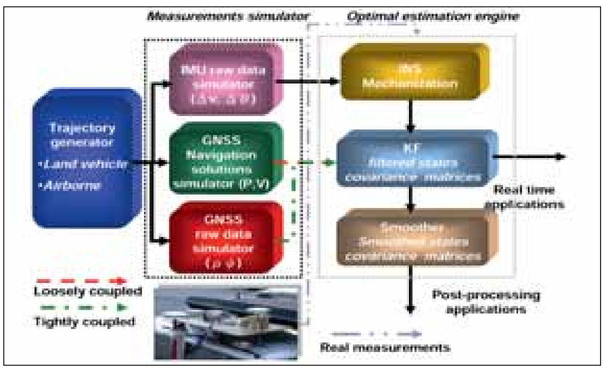

Fig 1: The architecture of proposed simulator

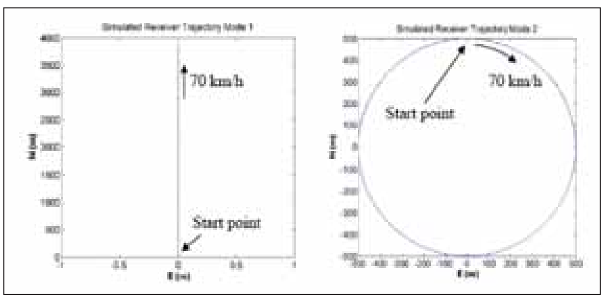

Fig 2: Straight lines and turn simulation

Inertial Navigation System (INS) that measures three orthogonal linear accelerations and three angular rates to calculate the navigation information is another navigation system used widely. In contrast to GPS, INS is self-contained and independent of external signals. Providing acceleration, angular rotation and attitude data at high update rates is the primary advantage of using an INS in land vehicles. However, the disadvantage of using an INS is that INS accuracy will descend rapidly because of the sensor errors (accelerometers and gyros) quickly growing with time. The accelerometer errors cause position error and the gyro errors result in the attitude errors. Therefore, an INS is used in the short-term case if no other navigation system or navigational aids (Schwarz and Wei, 2001).

Integrated INS/GPS systems can overcome the shortcoming of stand-alone GPS or INS so that provide superior performance. The position and velocity information from GPS is excellent external aid for updating the INS for improving its long-term accuracy, and the position and velocity derived from INS in short-term accuracy can be compensated for the system errors in real-time when the GPS signal intermits. However, the improvements come with price. The high cost and government regulations on INS have restricted such integrated systems of high quality INS and GPS until the Micro-Electro-Mechanical Systems technology came out. The introduction of MEMS based inertial systems bring a new science for integrated GPS/INS system. MEMS except for the compact and portable size, the price is far less than those high qualities Inertial Measurement Units (IMU). But due to compact size result in the noisy measurements and poor stability of INS, the performance of current MEMS IMUs can't reach the accuracy for general navigation applications.

Therefore, the research works concerning various INS/GPS integration algorithms is the core to improve the quality of such systems. However, it is very expensive

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To find out more about Dimensions 2010, visit **www.trimbledimensions.com** and not practical to purchase a lot of IMUs with various accuracies just to verify the performance of developed algorithms. Therefore, the development of a simulation platform that can simulate the trajectory of a moving vehicle and emulate GPS related and IMU measurements with various accuracies is preferred (Yang et al., 2007). Therefore, they can be regarded as a cost-effect tool to study the technologies concerning INS/GNSS integrated system. The availability of high-end INS is limited in Taiwan, therefore, the research communities as well as industries can adopt proposed software simulator and enable a low cost solutions to study the standard and advanced algorithms for INS/GNSS integrated system.

However, most of the INS/GPS simulators are available in hardware form thus they are pricy and their availability is restricted as well. For those software based simulators, they only work as a set of pseudo sensors that can only emulate measurements. None of them provide any optimal estimation engine for research or education purposes. Therefore, the objective of this study is to implement a software simulation platform including a trajectory generator, GNSS simulator; IMU simulator and optimal estimation engine. Comparing to other INS/GNSS simulation platforms, the proposed platform distinguishes itself from others by including the extended Kalman filter (EKF) and RTS smoother implemented in loosely coupled and tightly coupled architectures as the core of the optimal estimation engine. In addition, several practical issues concerning the filter tuning, the comparison between EKF and RTS smoother, and the comparison between EKF with loosely coupled and tightly coupled architectures are discussed to demonstrate the capability of proposed simulation platform.

The components of ins/ GNSS simulation platform

INS is entirely self-contained, which provide navigation information through direct measurements from IMU. INS has the advantage of independent from external electromagnetic signals, and its ability to operate in all environments. This allows an IMU to provide a continuous navigation solution. Given the ability to measure the acceleration by accelerometers, it would be possible to calculate the change in velocity and position by performing successive mathematical integrations of the acceleration with respect to time. Meanwhile, in order to navigate with respect to the inertial reference frame, it is necessary to keep track of the direction in which the accelerometers are pointing (Titterton and Weston, 1997). Such rotational motion can be sensed using gyroscopes. The above position, velocity and attitude (PVA) calculation is possible using a specific navigation integration algorithm (mechanization equations) by using only the signals from the inertial gyroscopes and accelerometers.

Generally speaking, the theory of the IMU simulator is an inverse process of IMU mechanization. Inertial sensors output can be derived from the vehicle's PVA information which is from the real test data or user's design. In this paper, the theory of IMU simulator is based on a strapdown inertial system with the configuration of three gyros and three accelerometers. The axes of the two triads are parallel and the origin is defined as the origin of the accelerometer triad. The inverse mechanization is established on the east-north-up (ENU) local level frame (LLF). The IMUS provides the user with binary IMU data and reference trajectory data with defined file formats.

In most civil applications, an IMU is often integrated with other navigation systems or sensors to provide both long term and short term navigation accuracy. The most popular is GPS. Integrated IMU/GPS systems provide an enhanced navigation system that has superior performance in comparison with either stand-alone system as it can overcome their limitations. In this simulator, the corresponding GNSS signals (i.e. Position and Velocity information) are also simulated with a defined data format to offer an effective way for evaluating a specific integrated INS/GNSS loosely coupled and tightly coupled architectures under different operational environments. The proposed simulation platform is composed of three major components: (a) trajectory generator, (b) measurement generators which include the measurements of IMU and GNSS, (c) optimal estimation engine which integrates INS with GNSS with Loosely-coupled and Tightly Coupled architectures using EKF and RTS smoother, respectively. Figure 1 illustrates the configuration of this simulator.

Principle of the simulator

Trajectory generator

To construct an INS/GNSS simulator, the first step is to design a trajectory generator. This generator not only can simulate the trajectory of a land vehicle but also can create

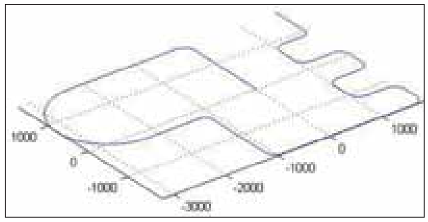

Fig 3: simulated trajectory

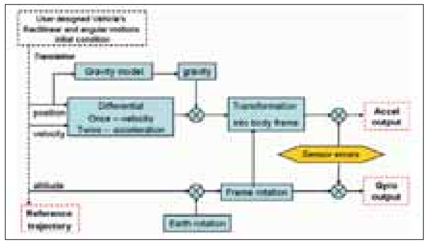
Fig 4: principle of simulator (Adopted from Yang et al., 2007)

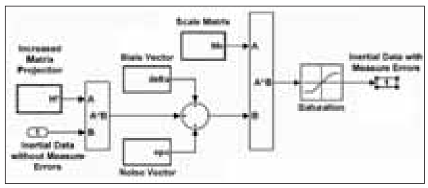
Fig 5: block diagram of the sensor error model (Adopted from Bennour et al., 2005)

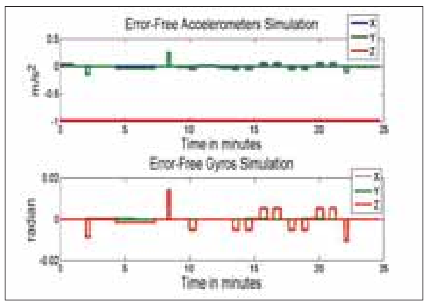

Fig 6: Error-free simulation of an IMU

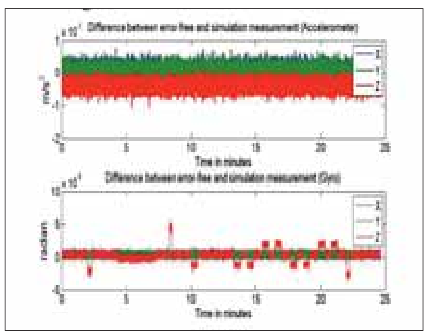
Fig 7: Difference between error-free and simulated IMU measurement

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a route in aviation. The most different part between land and aviation is the attitudes change in vehicle. Because of the changes in roll and pitch are very small when cars moving. So that it can be ignored while designing a ground trajectory generator but not in fly. Land and airborne dynamics can be considered as two different conditions; however their trajectory generators are implemented utilizing the same principle. The generator can created a "true" dynamic path by employing velocity, acceleration, angular velocity and each of their continued time. Figure 2 illustrate the simulation of a vehicle moving in straight line and turn respectively. A trajectory example with 25 minutes time span is shown on Figure 3.

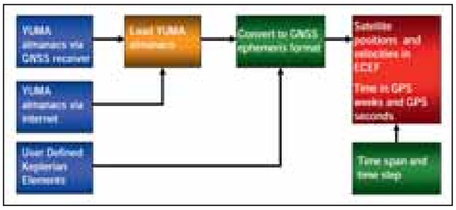
Fig 8: the calculation of satellite coordinate

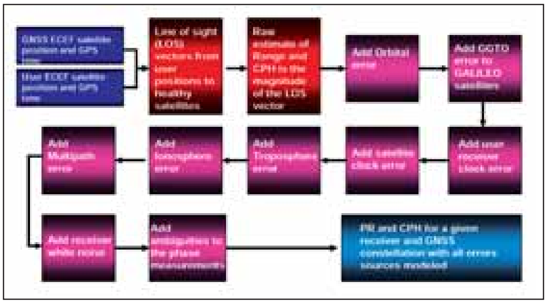
Fig 9: The generation of simulated GNSS measurements

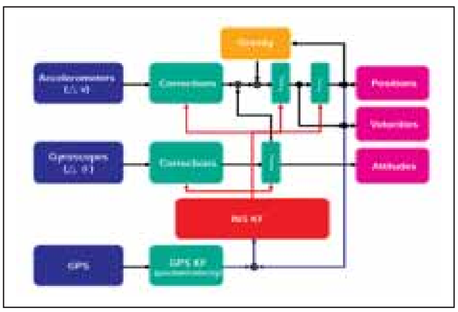
Fig 10: loosely coupled INS/GPS integration architecture (closed loop)

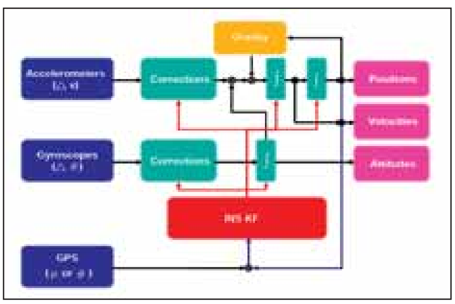
Fig 11: Tightly coupled INS/GPS integration architecture (closed loop)

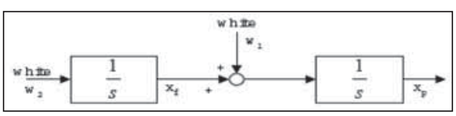
Fig 12: two-state GPS clock model (Adopted from Moon et al., 2000)

IMU measurement simulator

Four reference frames are involved in the implementation of the simulator. They are the inertial frame (denoted as i), in which the inertial systems comply with Newton's 1st and 2nd law of motion, the earth centered earth fixed frame (ECEF), the navigation frame, and the body frame. See Titterton and weston (1997) for details concerning these frames. The WGS-84 frame (e-frame) and the ENU LLF (l-frame) are applied as ECEF and navigational frames respectively. The body frame (b-frame) herein is defined as right-forward-up.

The conceptual principle of the IMU measurement simulator is shown in Figure 4. The vehicle's rectilinear and angular motions designed by the user are first translated to PVA information, which is related to the navigation frame. Differentiation of the PV information derives the acceleration when the gravity is combined. However, such acceleration is only a transitory quantity on the navigation frame with respect to the inertial frame. Frame rotation information is necessary to transform the acceleration to the body frame, in which the accelerometers measure the vehicle's translation motions with respect to the inertial frame. Frame rotation can be computed from the attitude when the earth rotation is combined. Frame rotation information indirectly provides the vehicle's rotational motions on the body frame with respect to the inertial frame, which are measured by gyroscopes. Translation and rotational motions plus various sensor errors form the inertial sensors outputs.

Applying the IMU velocity LLF mechanization equation (El-Sheimy, 2006) and considering an inverse process for the simulation, we have

$$f_{ib}^{b} = R_l^b \left[\dot{V}^l + \left(2\omega_{ie}^l + \omega_{el}^l \right) \times V^l - g^l \right] + \delta f \quad (1)$$

where, f_{ib}^{b} is the specific force vector along the three axes of the body frame, which is measured by the accelerometer triad, i.e. one of the outputs of the IMU measurements generator. The denotation of f_{ib}^{b} means the specific force on the b-frame with respect to the i-frame as observed on the b-frame. $\dot{V}^l$ is the vehicle's acceleration on the l-frame, which is differential of the velocity on the l-frame, i.e. V^l. ω_{ie}^l is the earth rotation rate projected on the l-frame, which is a function of position. ω_{ie}^l refers to the change of orientation of l-frame with respect to Earth, which is a function of velocity on the l-frame, position and the Earth's reference ellipsoid. g^l is the Earth's gravity. It can be calculated from the well-known normal gravity model. Titterton and Waston(1997) and Schwarz and Wei (2001) give such details. The symbol × refers to the vector cross-product. R_l^b is the transformation matrix rotating the vector from the l-frame to the b-frame. It is a function of vehicle's attitude. δf represents the accelerometer's errors. The errors depend on the error model assumptions. The next section will provide these details.

Since the rotation between coordinate frames can be expressed as a sum of rotations, in which one is absolute rotation and others are relative rotation, the output of the gyroscope triad ω_{ib}^{b}

$$\omega_{lb}^{b} = \omega_{ie}^{b} + \omega_{lb}^{b} + \delta\omega = R_l^b(\omega_i^{el} + \omega_l^{bl}) + \delta\omega \quad (2)$$

where, ω_{lb}^{b} is a function of vehicle's attitude and attitude change rate. $\delta\omega$ represents the gyroscope errors.

Equation (1) and (2) show that the inertial sensor outputs consist of two parts: error-free values and sensor errors. They are linearly combined. The error-free value is determined by the vehicle's PVA information.

Figure 6 shows an error-free simulation of both accelerometers and gyros. In this simulation, the sensor model takes into account the bias parameter, scaling factor and the noise level (Bennour et al., 2005). According to the following equation being the same for accelerometers or gyrometers:

$$\vec{X}_{mes} = \left(I + M_s \right) \times \left(\vec{X}_{true} + \vec{\delta}x + \vec{\varepsilon} \right) \quad (3)$$


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where

$\vec{X}_{mes}$ = measured variable of the sensor

$\vec{X}_{true}$ = noise free variable

M_S = scaling factor matrix

$\vec{\delta x}$ = bias on the sensor measurement

$\vec{\varepsilon}$ = noise of the sensor measurement

I = identity matrix

The execution of this sensor model is according to the block diagram in Figure 5.

	Bias or Drift	Scale factor	Noise
Accelerometer	0.0001g	5%	50 $ug/\sqrt{hr}$
Gyro	0.75 deg/hr	3%	0.1 $deg/\sqrt{hr}$

Table 1 The specification of IMU

Users can decide which error source to be included in the simulation. All error models can be set by the users as constant or function of time. Figure 7 illustrate the difference between error-free IMU measurement and measurement simulation using the specification of a tactical grade IMU. Table 1 shows the specification of the simulated.IMU.

GNSS Simulator

A GNSS simulator must be able to simulate satellites distribution in the future, all error sources and user dynamic path. Because of the errors of GNSS determine the accuracy of navigation system so that the system errors have to be modeled. The ionosphere, troposphere, error of satellite track and multipath effect are modeled in the simulator.

As the development of satellite navigation system, a GNSS software simulator allows user input the information of satellite system to get complete distribution of satellites and system errors. By inputting six Keplerian elements, the simulator can calculate the track and distribution of satellites. A satellite's track should be ellipse but past studies indicated that it can be replaced by circular form. Therefore, the calculation of a satellite's track and velocity can be simplified by ignored perigee and eccentricity. In fact, this simulator not only utilizes circular track but also employ the YUMA ephemeris which downloaded from internet. Figure 8 shows how the GNSS simulator provides coordinate of satellites.

Figure 9 indicates the simulation of GNSS measurement. It's clear to see that several kinds of error model are added in the process to make sure the result can approximate real measurement as possible.

Optimal estimation engine

It is common practice to use an EKF to accomplish the data fusion. Beside the Kalman filter, other filtering concepts are also known. These often account for the non-linearities of the system model, e.g. sigma point filters. But the nonlinearities are very moderate and, in general, these filters have shown identical performance in integrated navigation systems.

Several KF implementations are known. A widely used implementation is the closed loop error state space EKF. A strapdown inertial navigation system calculates continuously the position, velocity and attitude. As additional measurements become available, the EKF estimates the errors of these quantities. In a closed loop design these errors are fed back to the strapdown mechanization. That is the preferred way of integration with low cost or tactical grade IMUs as the accumulated systematic error sources and some of the attitudes errors tend to jeopardize the performance of navigation solutions. Although the closed loop seems is considered effective for all kind of situations; however, the estimator implemented in this study also includes open loop correction as an option.

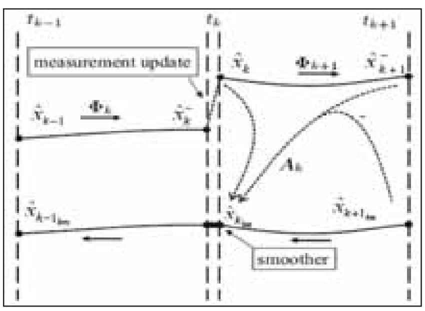

Fig 13: Forward and reverse run of a RTS smoother

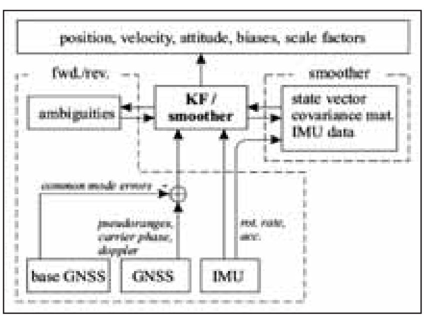

Fig 14: The flow chart of an INS/GNSS smoother

Loosely coupled INS/GNSS integration architecture

The Loosely coupled architecture is the simplest way of integrating a GNSS processing engine into a integrated navigation system. The GNSS processing engine first calculates position fixes and velocities in the local level frame and then send those solutions as measurements to the INS main kalman filter. By comparing the navigation solutions provided by INS mechanization with those solutions provided by GNSS processing engine, the error states can be optimally estimated.

As shown in Figure 10. The great advantage of loosely coupled architecture is, the simplicity of its implementation, because no advanced knowledge of GNSS processing is necessary. The disadvantage of implementation is that the measurement update of the integrated navigation system is only possible when four or more satellites are in view. But even if four satellites are in view the concept suffers in present implementations from the fact that the errors of the GNSS position fixes are not modeled correctly. Most GPS receivers provide only variances in direction of the axes of the coordinate system that is either the ECEF-frame or the local level frame. Generally, this is not a big problem if many satellites are in view and the GDOP is low. But in case of a poor satellite constellation, this results in a very conservative estimation of the position errors.

Tightly coupled INS/GNSS integration architecture

On the other hand, the tight coupled INS/GNSS system performs all the GNSS calculations by itself. The pseudoranges, carrier phase and instantaneous Doppler measurements are processed by the KF instead of the position and velocity fixes. Figure 11 indicates its process flow.

This involves that the ephemeris data has to be collected from the GNSS receiver and that satellite positions have to be calculated, if not provided directly by the GNSS receiver. The advantage of this approach is that the position error due to the satellite geometry is inherently correctly evaluated, because of the more detailed measurement model. Even if less than four satellites are available, aiding is possible.

The GPS receiver clock usually introduces a timing error that is translated into a ranging error. A two-state clock model is shown in equations (4)-(5) and figure12.

$$\dot{x}_f = w_2 \tag{4}$$

$$\dot{x}_p = x_f + w_1 \tag{5}$$

where x_p and x_p are the clock frequency error and the clock phase error, respectively.

The integration filter equation can be written as follow:

$$\dot{x} = \begin{bmatrix} \dot{x}_{nav} \\ \dot{x}_{sensor} \\ \dot{x}_{gps} \end{bmatrix} = \begin{bmatrix} F_{11} & F_{12} & 0 \\ 0 & 0 & 0 \\ 0 & 0 & F_{33} \end{bmatrix} \begin{bmatrix} x_{nav} \\ x_{sensor} \\ x_{gnss} \end{bmatrix} + \begin{bmatrix} w_{nav} \\ 0 \\ w_{gnss} \end{bmatrix} \tag{6}$$

where x_{nav}, x_{sensor} and x_{gnss} are, respectively, the inertial solution error, the inertial sensor error and GNSS receiver clock error; w_{nav} and w_{gnss} are zero-mean Gaussian white noises; the sub-matrices F_{11} , F_{12} and F_{33} are given by

$$F_{12} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ & & & 0 & 0 & 0 \\ & C_b^n & 0 & 0 & 0 & 0 \\ & & & 0 & 0 & 0 \\ 0 & 0 & 0 & & & \\ 0 & 0 & 0 & & -C_b^n & \\ 0 & 0 & 0 & & & \end{bmatrix} \tag{7}$$

$$F_{33} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \tag{8}$$

$$F_{11} = \begin{bmatrix} 0 & -\dot{\lambda}sL & \dot{L} & 1 & 0 & 0 & 0 & 0 & 0 \\ \dot{\lambda}sL & 0 & \dot{\lambda}cL & 0 & 1 & 0 & 0 & 0 & 0 \\ -\dot{L} & -\dot{\lambda}cL & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ -\frac{g}{R_e} & 0 & 0 & 0 & -(2\Omega+\dot{\lambda})sL & \dot{L} & 0 & -f_d & f_e \\ 0 & -\frac{g}{R_e} & 0 & (2\Omega+\dot{\lambda})sL & 0 & (2\Omega+\dot{\lambda})cL & f_d & 0 & -f_n \\ 0 & 0 & \frac{2g}{R_e} & -\dot{L} & -(2\Omega+\dot{\lambda})cL & 0 & -f_e & f_n & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -(\Omega+\dot{\lambda})sL & \dot{L} \\ 0 & 0 & 0 & 0 & 0 & 0 & (\Omega+\dot{\lambda})sL & 0 & -(\Omega+\dot{\lambda})cL \\ 0 & 0 & 0 & 0 & 0 & 0 & -\dot{L} & (\Omega+\dot{\lambda})cL & 0 \end{bmatrix} \tag{9}$$

RTS Smoother

According to Gelb (1974), there are three types of backward smoothing algorithms; fixed-interval smoothing, fixed-point (single-point) smoothing and fixed-lag smoothing. Only the fixed interval smoother will be considered in this study, see Gelb (1974), and Brown and Hwang (1992) for details concerning other smoothing algorithms.

The Rauch-Tung-Striebel smoother (RTS) was first presented in 1965 a few years after R. E. Kalman presented his filter in 1960(Gelb, 1974). The Kalman filter is a recursive filter that optimally, by means of maximum-likelihood, estimates the state vector of a dynamic system on the condition that a linear (or linearized) system model, past and current noisy measurements are known. In comparison with the KF, the RTS smoother calculates the most likely estimation of the state vector of a linear dynamic system on the condition that past, current and future measurements are known. Therefore it is only applicable in post processing, but promises improved accuracy, especially during GNSS outages.

The implementation of a RTS smoother may be regarded as an add-on to the Kalman filter. The data processing can be divided in two steps. In the first step the RTS smoother acts as an Kalman filter, but every time the system state vector changes, it and its variance-covariance matrix is logged into a file. If the system state changes in the propagation step of the KF, the state vector and the propagation matrix are logged too. But if the state changes due to a measurement update, no measurement data is logged, because it is not needed by the algorithm (Brown and Huang, 1992). In the second step, only the logged data is used by the algorithm. It is processed backward in time. The algorithm recursively estimates a new system state, by means of maximum likelihood. Figure 13 illustrates how the data is used. The upper part shows the forward run and the lower part the reverse run and the involved variables. The forward and reverse run of a RTS smoother is shown in Figure 13. Between two GNSS measurements the KF predicts the system state $\hat{x}_k^-$, by means of inertial navigation. When a new GNSS measurement becomes available, the KF calculates a new corrected prediction $\hat{x}_k$ but the longer the time between the measurements is, the greater the errors will become. Hence the KF trajectory contains great discontinuities. The smoother has the ability to level these discontinuities, by means of a new weighting of the previously calculated system states $\hat{x}_k^-$, $\hat{x}_{k_{km}}$ and $\hat{x}_k$. The final trajectory therefore is smooth and contains no discontinuities. The full smoother equations are given below:

$$A_k = P_k \Phi_k^T \left(P_{k+1}^-\right)^{-1} \tag{10}$$

$$\hat{x}_{k_{km}} = \hat{x}_k + A_k \left(\hat{x}_{k+1_{km}} - \hat{x}_{k+1}^-\right) \tag{11}$$

were P denotes the covariance matrix $\hat{x}$ of. $P_{k_{km}}$ can be calculated as follows, but is no need for the algorithm:

$$P_{k_{km}} = P_k + A_k \left(P_{k+1_{km}} - \hat{x}_{k+1}^-\right) \tag{12}$$

Figure 14 illustrates the flow chart of the overall system. If it acts as KF, the logged measurement data can be processed forward or reverse in time, while resolved ambiguities are loaded from or saved to a file. All the state and covariance data of the permanent state variables is also written to a file for further use in smoother mode.

The states of the ambiguities are neglected, because they are of no use in the smoother pass. The inertial data is also logged with the state and covariance data for an easier usage by the smoother. If the system acts as a smoother, only the logged data is used. The number of passes and the direction in KF mode can be chosen arbitrary. After a KF pass, it is always possible to invoke a smoother pass.

To be concluded in November 2010

WorldView-3 development

DigitalGlobe has contracted Ball Aerospace & Technologies Corporation to build its next imaging satellite, WorldView-3. ITT Corporation has been contracted to build the imaging system, which will be capable of capturing 8-band multispectral high-resolution imagery. The WorldView-3 satellite scheduled for launch in 2014. *www.digitalglobe.com*

Bluesky's Aerial Photopacks resolve boundary disputes

Bluesky has launched a new way to obtain irrefutable evidence for use in boundary disputes and other land based disputes or studies. The OldAerialPhotos Photopack contains; one archive aerial photograph of a location in the past and a corresponding image from the most recent aerial survey. It also contains A4 printed versions of the aerial photos, a certificate of authenticity, a copy of the archive search details and the supporting flight report from the archive scan (where available). *www.bluesky-world.com*

China launches new Mapping Satellite

China has launched a mapping satellite, "Mapping Satellite - I" developed by a company under the China Aerospace Science and Technology Corporation (CASC). It would be mainly used to conduct scientific experiments, carry out surveys on land resources, and mapping. The remote sensing information and test results from the satellite would promote the country's scientific research and economic development, said the statement. *www.chinaview.cn*

RS to strengthen UK disaster response

DMCii is leading a new European Space Agency (ESA) project to design and build a system for the UK civil resilience community - those tasked with responding to and recovering from disasters - putting space-based systems at their disposal. The system will be used for all types of emergencies listed in the UK's National Risk Register but the project's focus is on flood scenarios. *www.dmcii.com*

NZ quake cleanup

New Zealand's emergency services are now able to access the spatial data and aerial imagery online to assist with the clean up of the earthquake damage. The online service, developed by the Australian Research Collaboration Service and known as BeSTGRID, is normally used to share data between New Zealand research organizations. *http://spatialsource.com.au*

IIRS to study 14 major river basins

The Indian Institute of Remote Sensing (IIRS), Dehradun, India has initiated a study of 14 major river basins in the country. The study, under Indian Space Research Organization's (ISRO) geosphere biosphere programme, will determine the land use and land cover dynamics in these basins. The project, titled, 'Land use and land cover dynamics and impact of human dimension on Indian river basins', aims at exploring the changes in river basins over the last 20 years, based on which future land use and land cover scenario will be determined. *http://timesofindia.indiatimes.com*

NASA satellite data aid UN to detect global fire hotspots

The UN FAO has launched a new online fire detection system that will help firefighters and natural hazards managers improve response time and resource management. The Global Fire Information Management System (GFIMS) delivers fire data from an imaging sensor aboard NASA's Terra and Aqua satellites to generate daily fire maps and images through a freely accessible Web interface. The system also dispatches detailed email alerts of the quantity and coordinates of fires, and it does so less than three hours after a satellite passes over burning land. *www.nasa.gov*

Russia is biggest buyer of India's space images

Russia is the largest buyer of earth images taken from space by Indian satellites, Murthy Remilla, Deputy Director of Antrix Corporation Limited, told RIA Novosti. "Our main clients in Russia are the Defense Ministry, the Agriculture Ministry and the Federal Forest Service," Remilla said. *http://in.rbth.ru*

RapidEye's quick collection of the US

RapidEye announced that over a period of three months, 95% of the contiguous United States has been imaged. Almost 80% of this imagery was captured by the RapidEye satellites with less than ten percent cloud cover. All of this imagery is available for purchase in the RapidEye Library. *www.rapideye.de*

LockMart advancing on GeoEye-2

The Lockheed Martin team developing GeoEye-2, has successfully completed on-schedule a System Requirements Review (SRR), an important program milestone that precedes the Preliminary Design Review. The launch of GeoEye-2 is scheduled for 2013. *www.geoeye.com*

Galileo update

Malta foregoes bid to host Galileo

Malta has officially informed the European Commission that it no longer wants to host the headquarters of Galileo, four years after it submitted its official bid. Other member states who were also trying to win this prestigious agency also withdrew their bids, including Italy, France and the UK. There are now only two member states vying for the Galileo Supervisory Authority – Czech Republic and Slovenia. *www.timesofmalta.com*

Navigation satellites contend with stormy Sun

It is a fact that variations in the Sun have effects that extend far out into the Solar System. And the solar activity follows a roughly 11-year 'sunspot cycle'. That means the next 'solar maximum' – solar max for short – is due in 2013, not long after ESA launches its first four operational Galileo satellites. "These Galileo In-Orbit Validation (IOV) satellites will indeed go up during a period of enhanced solar activity," explains Bertram Arbesser-Rastburg, head of ESA's Electromagnetics and Space Environment division. "But the solar max is hardly a surprise event. Astronomers counting sunspots have tracked the solar cycle for more than 250 years. All the indications are this solar max will not be especially energetic – the last solar minimum has been unusually long and deep."

"So it's reassuring the Galileo satellites won't be faced with the worst of the worst on day one. But in any case, they have indeed been built to endure the worst of the worst: even then, they would not fail." The Sun has various potential impacts that satnav system designers must take account of. The first can indeed affect satellites themselves: electromagnetic radiation and charged particles from solar flares can disrupt satellite electronics, induce potentially harmful electrostatic charging and damage onboard materials.

Galileo satellites were designed with precise data on the radiation hazard they faced: in 2005 and 2008 a pair of test satellites, Galileo In Orbit Validation Element (GIOVE) –A and –B, were launched into the constellation's future orbit. The satellites were fitted with radiation monitors, still returning data to this day.

"Dynamic in nature – especially around where the Sun is shining – the ionosphere may cause noisy scintillations leading to ground receivers losing their satellite locks," added Arbesser-Rastburg. "Depending on its local density or 'total electron count', the ionosphere can also delay a signal passing through it, amounting to a navigation error on the order of tens of meters."

Added certainty is given by regional overlay systems: the Wide Area Augmentation System (WAAS) for North America and the European Geostationary Navigation Overlay Service (EGNOS) for Europe, with other systems in development.

"What EGNOS offers is an assurance of integrity for European users of GPS and later Galileo signals," explained Arbesser-Rastburg. "As well as checking the correctness of satellite orbits and clocks, its pan-European network of ground stations measure small changes in the total electron content of the vertical ionosphere above them to deliver local corrections. This is vital when it comes to planned 'safety-of-life' uses such as civil aviation. *www.esa.int*

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MICHIBIKI successfully launched

Mitsubishi Heavy Industries, Ltd. and the Japan Aerospace Exploration Agency (JAXA) launched the first Quasi-Zenith Satellite "MICHIBIKI" by the H-IIA Launch Vehicle No. 18 (H-IIA F18) from the Tanegashima Space Center. The launch vehicle flew smoothly, and, at about 28 minutes and 27 seconds after liftoff, the separation of the MICHIBIKI was confirmed. *www.jaxa.jp*

First GPS IIF Satellite set healthy

Officials from the Space and Missile Systems Center's GPS Wing announced that the first GPS IIF satellite (SVN-62) has been set healthy to navigation and timing users worldwide. *www.losangeles.af.mil*

Flex Power test for GPS wraps up

The 2nd Space Operations Squadron has conducted a Flex Power Integration Assessment of the GPS space and control segments to confirm functionality delivered in AEP 5.5.0D - a recent software upgrade that will enable the ground system to command and control the new GPS IIF satellite. *www.afspc.af.mil*

Three GLONASS satellites put into orbit

Three GLONASS satellites have been put into orbit. "The launch and flight of the carrier rocket, as well as the separation of the satellites, took place on schedule," said Alexei Zolotukhin spokesman for the Russian Space Forces. He also said the satellites' onboard systems were working well. Only two out of these three satellites will be put into operation. The third will be kept in reserve. *http://en.rian.ru*

Satellite Navigation steers unmanned Micro-Planes

An unmanned aircraft system guided by satnav has been developed within ESA's Business Incubation Centre to provide rapid monitoring of land areas and disaster zones. MAVinci, Germany has developed the new system that uses autonomous micro-air vehicles (MAVs) with a wingspan of less than two meters, to inspect land areas. The autopilot controls the aircraft from takeoff to landing, and uses satnav to follow a planned track, triggering the camera to image the target area. *www.mavinci.de*

BrahMos missile using Glonass receivers

BrahMos Aerospace Ltd., a Russian-Indian joint venture manufacturing supersonic cruise missiles, is successfully using Glonass receivers for aiming and target acquisition. *http://en.rian.ru*

GPS iPhone App for runners

Nike has launched a new app that allows runners to use their iPhone to visually map every run while tracking pace, distance and time. The app uses the iPhone's GPS capabilities to map a run as it happens, allowing runners to keep track of their exact routes and distances run. *www.nike.com*

India Update

Traffic police wants GPS in call centre cabs

The Delhi Traffic Police has instructed all the call centre cab operators to install GPS in their cabs so that their movements can be tracked. *www.hindustantimes.com*

Trains in India to use GPS

GPS will be installed on trains in the next two years to avoid accidents, Indian Railway Minister Mamata Banerjee has said. *http://timesofindia.indiatimes.com*

Russia's NIS inks MoU with India's HBL on GLONASS

Russia's Joint Stock Company Navigation-Information Systems (JSC NIS) signed a MoU with India's Hyderabad-based HBL Power Systems Ltd on GLONASS navigation systems with an aim to promote the GLONASS system in India. *www.brahmand.com*

ESRI Releases the Open GeoServices REST specification

ESRI released the GeoServices REST Specification, which provides a standard way for Web clients to communicate with GIS servers through Representational State Transfer (REST) technology. It has been opened such that developers can expose the GeoServices API request structure from ArcGIS Server and other non-ESRI, back-end GIS servers or processors. *www.ESRI.com*

Bentley Future Cities China Student Design Competition

The Center for International Business Ethics (CIBE) in Beijing, the Dynamic City Foundation, and Bentley Systems announced that the project designed by the student team from the Architecture Department of Tsinghua University won top honors in the inaugural Future Cities China design competition. The competition was open to all students studying architecture and engineering in institutions of higher education, but all essay submissions had to be in Chinese. The program challenged students to use their design skills, along with Bentley software, to provide a master plan for the sustainable university campus of tomorrow. *www.bentley.com*

China grants web mapping licenses to 31 firms

China has granted licenses to 31 companies to provide web mapping services in the country. Under new rules introduced all firms providing Internet map and location services in China are required to apply for approval from the State Bureau of Surveying and Mapping (SBSM). Foreign firms wanting to provide those services in China are required to set up joint ventures or partnerships with local firms. *http://news.theage.com.au*

ikiMap launched

Sixtema ikiMap is a free web service which allows its users to create and share their maps. The objective is to combine the concept of a social network together with the use of cartography and maps. *www.sixtema.es*

CARIS measures improved performance with SFE

CARIS released Spatial Fusion Enterprise (SFE) version 5.3 featuring the new Web Map Tile Service (WMTS). SFE allows an organization to deliver its geospatial information to the Web using open standards and the latest technology. WMTS also allows multiple layers from any number of data sources to be grouped into a single layer prior to being drawn. *www.caris.com*

Intergraph Public Safety and Security Software

The Kingdom of Jordan has deployed Intergraph® public safety and security incident management software. It will help to prevent and respond to local and regional terrorism threats and related security challenges. *www.intergraph.com*

GISRoam™ iPad GIS V 1.4

Cogent3D released GISRoam™, Version 1.4. It is a mobile GIS application for when you are away from your desk and need to review Shapefile layers, edit Shapefile layers, search Shapefiles, colorize Shapefile layers, and update Shapefile layers on your iPad/iPhone. *www.Cogent3D.com*

OpenGeo announces support for Multiple Cloud Infrastructures

OpenGeo released OpenGeo Suite Cloud Edition in collaboration with Skygone Inc. It is optimized for cloud infrastructure, with special features preconfigured for scalability, and performance enhancements already installed. *http://opengeo.org*

China Economic and Social Indicators on SuperWebGIS

SuperGeo Technologies has developed 'China Economic and Social Indicator GIS', a platform that provides thematic maps and statistic charts to study the future development trend of Mainland China. *www.supergeotek.com*

NAVTEQ give navigation a 'Human Touch'

NAVTEQ Natural Guidance™ enables guidance through the use of descriptive reference cues. Research shows consumers want more intuitive and practical directions because they are easier to follow and allow drivers to keep their eyes on the road. The system enables applications to use recognizable and easily understandable points of reference close to the decision point to highlight the next maneuver. *www.navteq.com*

Commercial launch of Telmap5

Telmap5 Mobile Location Companion is the next generation of SFR's existing Find & Go service and in addition to the complete navigation offering. *www.telmap.com*

TeleNav launches navigation-based Mobile Advertising Platform

TeleNav announced a drive-time search and navigation mobile advertising platform developed to transform the way in which advertisers reach millions of on-the-go users. It delivers a relevant and targeted ad to users based on the location and context of their search query. *www.telenav.com*

2014: Free navigation forecast

According to a recently published report by SBD, navigation software is rapidly becoming a commodity in Europe and USA, which will lead to standard-fit navigation on smartphones accounting for over 70% of all navigation systems shipped in 2014. *www.sbd.co.uk*

Western Europe PND dip 1H 2010

According to GfK, in the first half of 2010, the average price and demand are decreasing for PNDs, and as a result, sales revenue shrank by around 21%in the six Western European countries of Germany, Italy, France, the UK, Spain and the Netherlands. *www.worldtech24.com*

MapmyIndia debuts maps with house addresses

MapmyIndia released their latest database that includes house addresses for the two metropolitan areas of Delhi NCR and Chandigarh. The company is pursuing this house addresses mapping initiative in other regions. *www.mapmyindia.com*

Garmin recalls 1.25m PNDs

Garmin is voluntarily recalling approximately 1.25 million nüvi PNDs that contain batteries manufactured by a third-party supplier within a defined date code range and that have a specific printed circuit board (PCB) design. It has identified potential overheating issues when the third party supplier's batteries manufactured within this limited date code range are used in certain Garmin devices with the PCB design. *www.garmin.com*

Unmanned Ground Vehicle Conversion kits

Boeing and Bolduc Technology Group to design, develop, integrate, test, manufacture and sustain agnostic autonomous-navigation kits for ground vehicles. The kits would enable human-driven vehicles to be converted into autonomous or remotely operated vehicles for commercial or military use. *www.boeing.com*

Free Evaluation version of Accuracy Analyst™ from SIS

Accuracy Analyst™ is the free evaluation version that makes data access and new capabilities in version 2.3 of the software available, but limits the number of checkpoints as well as analytics and report generation capabilities. It is active for 30 days. *www.spatialis.com*

Skoda uses Ashtech® ProFlex™ 500

Skoda has selected Ashtech ProFlex 500 GNSS receivers to measure the dynamic movements of its new models as they accelerate through high-speed tight test maneuvers. *www.ashtech.com*

HP goes ahead in time with architects and designers

Hewlett-Packard India recently announced the winners for Skyline 2020 an online national design contest initiated by HP. The contestants submitted their designs online between April and August 2010 and were judged by an eminent jury of renowned architects. The team winning the national award comprises Anto Gloren and Sayali Athale of Marathwada Mitramandal's College of Architecture, Pune. Skyline 2010 created a gateway to open up infinite latent possibilities, which can transform our city and alter the way future generations experience the city through the lens of its skyline. The competition saw over 600 professionals and students participate with their outstanding perception on the skyline of the future from all across India. Present at the event were Guayente Sanmartin - Director-Designjet Business, HP Asia Pacific & Japan, Puneet Chadha - Director, Graphics Solutions, HP IPG India and as well as jury member and keynote speaker Sen Kapadia along with other players from architecture and design industry. *www8.hp.com*

Hemisphere GPS

New R131™ DGPS receiver

Hemisphere GPS R131 DGPS receiver is a rack-mountable addition to the R100™ Series of DGPS receivers. It allows for consistent sub-meter performance with standard SBAS differential and Hemisphere GPS' exclusive COAST™ technology which maintains accuracy during temporary loss of differential signal.

Multi-GNSS receiver technology

Hemisphere GPS next generation Eclipse II GNSS receiver technology and the Eclipse II OEM board – the first product incorporating these technological advancements. Eclipse II provides improved RTK performance, GPS, GLONASS, SBAS, and OmniSTAR® support, and reduced power consumption.

Earthworks X300

Integrating Hemisphere GPS' patented Crescent Vector GPS compass technology X300 measures and displays 3D excavator positioning to operators, improving excavation proficiency and accuracy and reducing rework. *www.hemispheregps.com*

Bentley adds three product firsts to OpenPlant

Bentley Systems three new products in Bentley's OpenPlant software for plant creation is based on an open data model. It meets the primary goal of the iRING user community – that is, to enable real-time, seamless sharing and interoperability of data and information across different organizations and systems using an internationally recognized standard. *www.bentley.com*

Technology alliance

Emergent Space Technologies and Loctronix Corporation to explore market opportunities for Loctronix's patented Spectral Compression Positioning™ (SCP) within the space and military industries. *www.emergentspace.com*

NovAtel announces SMART-MR10™ GNSS Receiver/Antenna

NovAtel SMART-MR10 is the first in a new family of GPS+GLONASS L1+L2+L-band integrated receiver and antenna products. The SMART-MR family is designed specifically for on-machine Agriculture, Construction and Mining applications. It provides scalable positioning accuracies down to 2cm. It supports GL1DE® firmware, which uses the very accurate carrier phase measurements to provide ultra smooth positions and highly accurate pass-to-pass capabilities. *www.novatel.com*

Intergraph® introduces 3D capabilities in Geospatial Software

Intergraph has introduced new 3D capabilities for its GeoMedia® product line, fully integrating advanced spatial analysis and data capture with the 3D 'virtual earth' style of presentation popular in today's mainstream mapping applications. The combination delivers

Leica Geosystems

Leica M-Com

Leica Geosystems GeoMoS v5.1 features the new Leica M-Com series, a compact plug & play solution for reliable and stable monitoring communication. It seamlessly integrates Total Stations, GNSS receivers and antennas, geotechnical sensors, software, and IT communication infrastructure. Leica GeoMoS v5.1 supports the latest Microsoft Windows 7 operating system.

Zeno series updates

Leica Zeno Office v1.1 and Zeno Field v1.1 software updates are for the Zeno series of GNSS/GIS products. It offers a multi-functional and easy-to-use GNSS/GIS solution with superior performance. It provides a unique one-click automated workflow between field and office to greatly enhance productivity and ease-of-use.

SP Technology

Leica Geosystems SP technology opens new opportunities for dozers, combining ease-of-use, flexibility, and precision at fast speeds. It provides improved hydraulic control that allows faster grading with outstanding smoothness and precision at high speeds. *www.leica-geosystems.com* more precise visualization of surface and environmental characteristics for increased insight, data accuracy and user productivity. *www.intergraph.com*

SAIC awarded contract by the NGA

Science Applications International Corporation (SAIC) has been awarded the Total Application Services for Enterprise Requirements (TASER) contract by the National Geospatial-Intelligence Agency (NGA) to research and implement innovative solutions to emerging critical geospatial intelligence requirements. The multiple award, indefinite-deliver/indefinite-quantity contract has a five-year base period and a total value of $1 billion for all awardees. *www.saic.com*

Trimble expands GPS Handheld Series

Trimble® Juno™ SD handheld is an addition to the pocket-sized Juno series of field computing devices with integrated GPS technology. It builds on the core functionality of all Juno series models with the addition of integrated 3.5G High-Speed Downlink Packet Access (HSDPA) cellular SMS and voice capability. Using the data transmission capabilities of the Juno SD handheld, mobile workers can access information in the field such as work-orders, map data, reference files, emails, and Internet resources easily. *www.trimble.com*

AEM announces Geospatial Industry Group establishment

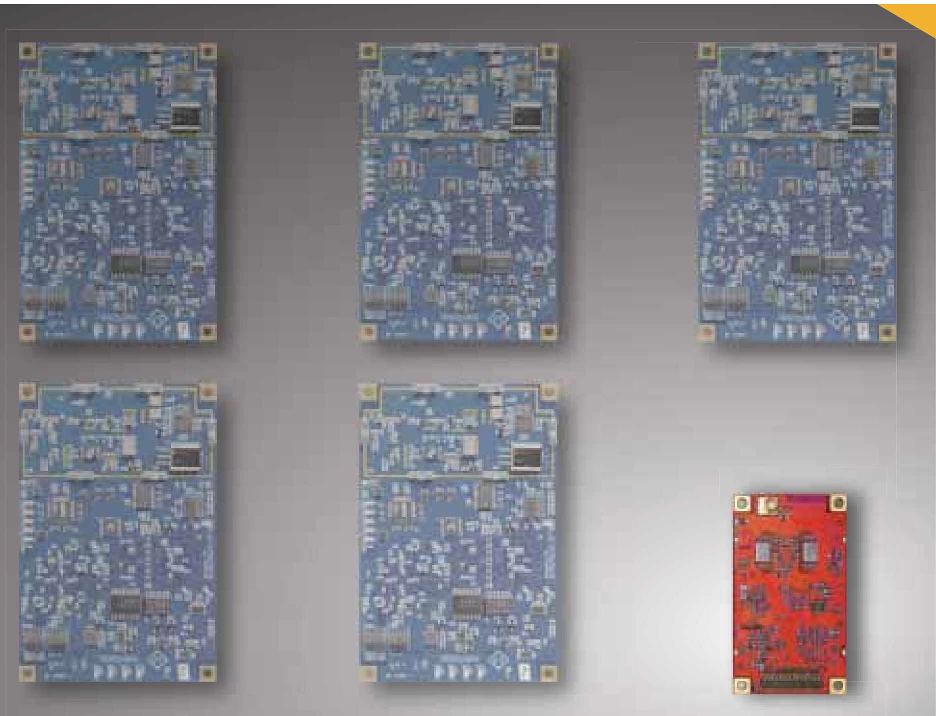
The Association of Equipment Manufacturers (AEM) announced the formation of a new product group – the AEM Geospatial Industry Group – to serve manufacturers of various types of surveying/positioning systems such as GPS and GIS/LIS. Product groups in AEM provide a forum for manufacturers of similar equipment to discuss and take action on industry issues of mutual interest. www.aem.org

Global Maritime SaComm market passes $1 billion

Euroconsult in a new report "Maritime Telecom Solutions by Satellite: Global Market Analysis & Forecasts" has forecast that the number of satellite communications terminals aboard commercial and private ships will more than double over the next decade as demand for bandwidth on the high seas continues to surge.*www.euroconsult-ec.com*

u-blox introduces LEA-6R GPS

u-blox LEA-6R is a next-generation GPS module based on the u-blox 6 platform. The surface-mount module comes with u-blox' proprietary "Sensor Fusion Dead-Reckoning" technology integrated. The module is designed for after-market devices requiring uninterrupted navigation even during poor GPS signal reception. *www.u-blox.com*

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Unmatched Accuracy and Performance with SBAS
Submeter Solutions without Post-Processing
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