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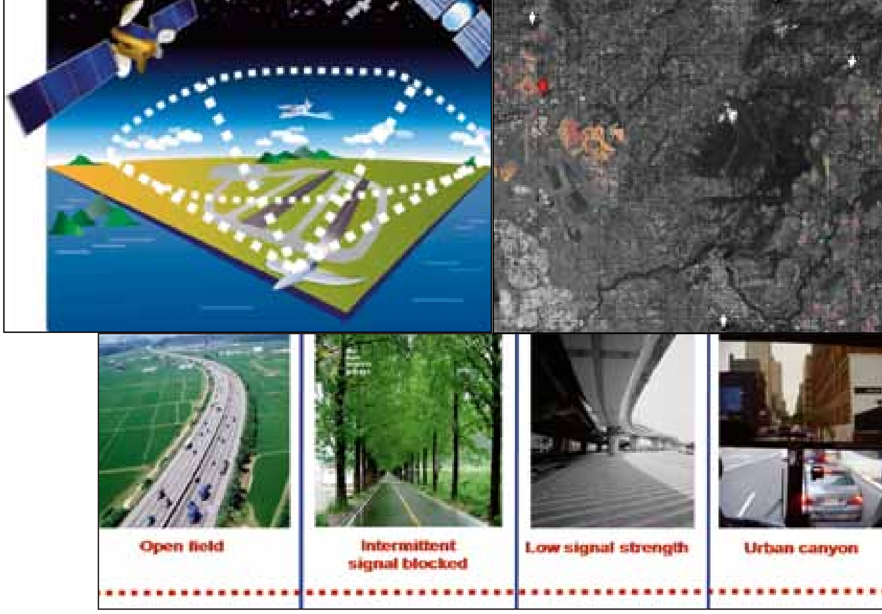

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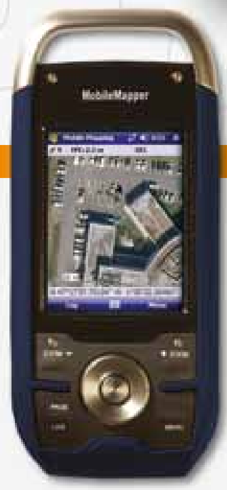

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The spill and the spill over

The Gulf of Mexico oil spill

A botched job

An unfolding disaster...

with a long lasting impact

Incidentally, more affected ones happen to be the most powerful.

The blame game is on...

Definitely, there is a mounting crisis.

Once again

Any lesson learnt?

Bal Krishna, Editor
bal@mycoordinates.org

Transport planning in Korea

Establishment of nation-wide transportation infrastructure with GNSS technology would facilitate development of the next-generation growth engines in areas of telematics and intelligent cars

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During the last half century, countries all over the world went through a remarkable economic growth, which resulted in higher income levels and changes in people's way of living. In particular, transportation industry has undergone a dramatic change. The number of privately owned cars has explosively increased to facilitate individuals' travel. Volume of goods transportation also rose sharply due to expanding global trade and online commerce. Increasing volume of traffic has led to chronic traffic congestion, environmental pollution and traffic accidents, which means higher social and economic cost, as well as loss of life and goods. Countries with advanced transportation system such as the U.S, E.U and Japan are responding to rising traffic demands through efficient management of traffic systems, by expanding traffic facilities and utilizing information technology. These countries have long used Global Navigation Satellite System (GNSS) which is widely used to enhance safety and efficiency of transportation by providing position information of vehicles. GNSS is used not only to determine vehicles position but to charge toll fees and gather information on goods transfer, and so on.

Recently, there is a rising demand to develop a nation-wide infrastructure technology in order to address transportation issues in eco-friendly, low-cost manner, and to enhance safety and efficiency of transportation. Rapid advancement of IT brought about Intelligent Transportation System, leading to real-time traffic information. In future, it is expected that the land transportation system would use even finer control methods, and to do so, it is necessary to improve accuracy and reliability of position information. This, in turn, calls for an upgraded infrastructure to provide position information. Currently, there are many technologies that are available to gather position information for land transportation, but their use is limited due to technical issues or high price. To overcome these issues, studies are being conducted on GNSS. Noting this trend, Korea Aerospace Research Institute (KARI) are also working on the project "Development of GNSS-based transportation infrastructure technology" to respond to future transportation system and to expand the use of GNSS for land transportation.

Necessity of research

With rapid increase in land transportation volume and diversified transportation systems, related problems are getting more complicated in terms of traffic congestion, accidents and air pollution (Fig. 1). Many endeavors are being made to address these issues in an environment-friendly way and at a low cost. In particular, use of GNSS is taking off, and there is a rising demand to develop a new infrastructure to optimize use of GNSS for land transportation. Use of GNSS has been extensively studied for air and

Fig. 1 Current land transportation problems – traffic congestion, accidents and air pollution

maritime transportation, which have a relatively favorable environment to receive signals from GNSS (Fig. 2). In both areas, agencies like International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO) are actively undertaking research to drive performance requirements of navigation systems. The drive for navigation performance requirement of land transportation is less active. Because the transportation environment is different, a system for land transportation cannot adopt performance requirement of GNSS estimated for air and maritime transportation. For instance, many obstacles such as high-rise buildings, overpasses and large signboards make it hard to receive signal from GNSS, unlike in the air or at sea. As a result, it is extremely difficult to set a performance requirement depending on operating mode of a vehicle (Fig. 3).

Necessary technology

Currently, use of GNSS is mostly limited to notifying user's position on the road; it does not ensure reliability of the information. In order to improve user's security and efficiency, road information needs to be more reliable. Thus, in developing GNSS-based transportation infrastructure, the goal is to provide accurate position information to improve safety and efficiency of the system, at a designated position-exterminating point, for land transportation. Figure 4 lists detailed goals in developing technologies to provide position information based on GNSS code and carrier phase measurements, improve reliability of information through signal monitoring and to standardize GNSS based transportation infrastructures.

Technologies used to develop GNSS-based infrastructure include infrastructure system design, generation of error correction information, generation of integrity information, GNSS signal acquisition performance improvement, multiple navigation sensor fusion. Figure 5 illustrates technologies required to utilize GNSS signal for land transportation. Infrastructure design technology indicates system configuration to build GNSS-based transportation infrastructure system. Korean companies have little experience in designing infrastructure system and are heavily dependent on foreign technology. It is important to develop technology to design an independent system. Generation of error correction information means processing and providing error elements to remove signal error in GNSS. Code measurements-based information correction technology has reached a level to enable real-time operation, but carrier phase measurements-based technology is lagging behind. Generation of integrity information indicates a technology to process and provide information to alarm users with risk of the location information. Studies are under way for simple algorithm to generate integrated information, but empirical test on technology of detecting anomaly of true ionospheric layer is non-existent. GNSS signal acquisition performance improvement means developing adoptive technology under weak signal. Multiple navigation sensor

Fig 2. Environment of signal acquisition for air and maritime

Fig 3. Environment of signal acquisition for land transportation

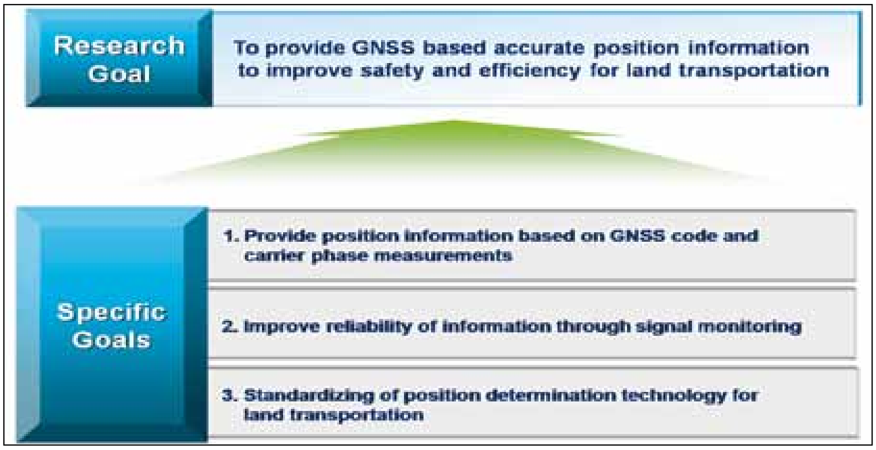

Fig 4. The goal of Development of GNSS-based transportation infrastructure technology

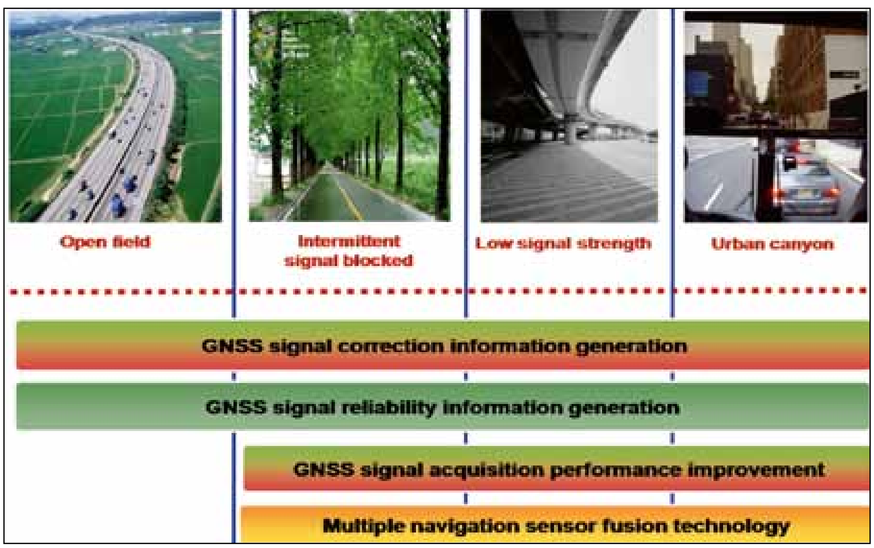

Fig 5. Required technologies to utilize GNSS signal for land transportation.

FOIF GNSS Receiver A20

More flexible system with following features:

- Fully rugged design with simple "One Button" base setup
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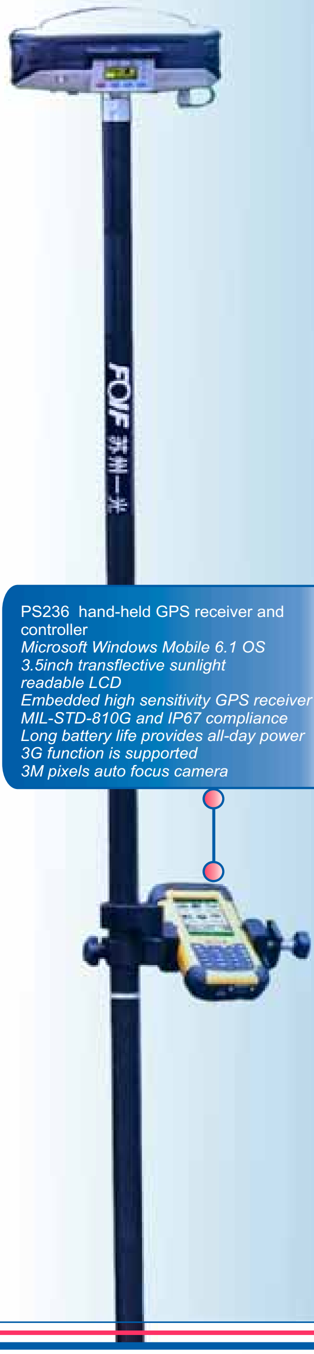
- Compatible with existing popular brand GNSS systems
- It is available for wireless data link by FOIFNet transceiver
- GPRS data link reconnecting automatically as base station
- Switch from internal radio to GPRS, or both can work together
- RTK Network rover:VRS, FKP, MAC
- Modular design - simple to extend or replace the Bluetooth, radio or GPRS and SD/SIM card module
- Field software: FOIF Survey_GPS or FOIF FieldGenius



PS236 hand-held GPS receiver and controller
Microsoft Windows Mobile 6.1 OS
3.5inch transflective sunlight readable LCD
Embedded high sensitivity GPS receiver
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fusion technology of low-cost sensors (IMU, DR, visual sensor) and GNSS satellite signals to determine a user position. Sensor coefficients (code-based, GPS/INS/DMI-based) and convergence technologies are in place. However, carrier phase measurement -based multiple navigation technology is still in a nascent stage of exploration and algorithms development.

In order to determine position using GNSS for land transportation, Technologies for user are required in addition to infrastructure technology. Figure 6 describes development strategy to realize "Development of GNSS-based transportation infrastructure technology" A system configuration to build GNSS-based land transportation infrastructure roughly consists of satellite navigation signal sensor station, central processing station, and users. Additionally, signal transmission is needed to transfer correction, integrity and assistance of information between central processing station and users. The signal sensor station collects signals from the satellite, and provides the central processing station with information received, tracked and collected. The central processing station processes necessary information using raw data from the sensor station. To use the service, a user needs a device equipped with technologies to utilize corrected, integrity information. The signal sensor station gathers data, and the central processing station processes the data to generate corrected, integrity, and signal-enhancing information to deliver to the users. Finally, a user determines its own position. Figure 7 illustrates an overall process of user's position determination based on land transportation infrastructure technology.

"Development of GNSS-based transportation infrastructure technology" can be divided into four stages: research on basic technology, study of core and applied technology, preparation for operation of test bed, and pilot project (Fig. 8).

In the first stage, technology intensive studies are performed in regard to generation of corrected, integrated information. Also, technologies—whose applicability can be verified—are developed for land transportation areas with relatively good visibility, excluding system aspects such as communication delay. In the next stage, in-depth research is conducted for the technologies explored in the previous stage. This includes establishment of small-scale experiment environment and test evaluation. Core technology refers to technologies that can yield a certain level of outcomes through R&D, based on basic technologies. Core technology cannot be produced in a short period of time. Applied technology indicates technologies required to apply basic and core technologies to an actual system. In the stage of building and operating a test bed, all three levels of basic, core and applied technologies are tested in actual operating environment, and checklist is inspected. A test bed means testing environment to decide how to configure an actual system in applying basic, core and applied technologies. A pilot project is implemented to analyze feasibility of the system, before establishing infrastructure all over the country. However, pilot project is beyond the scope of this research project.

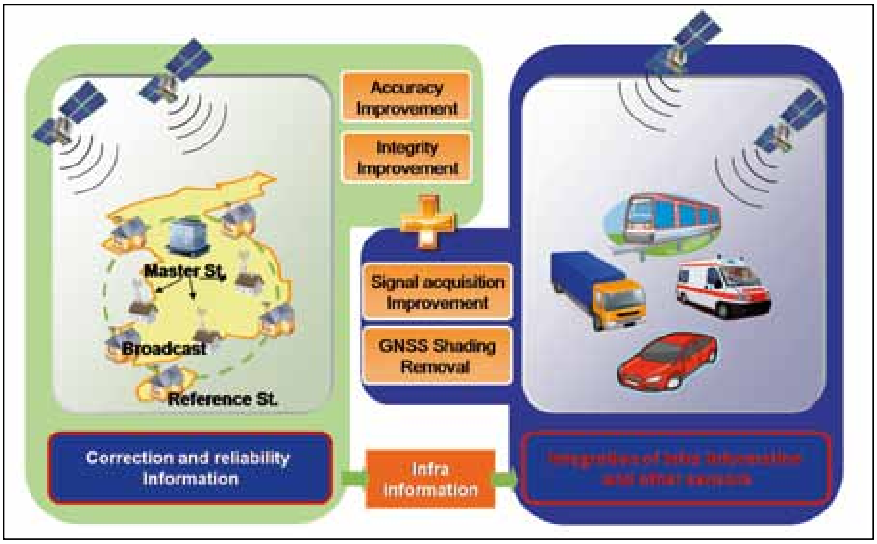

Fig 6. Development strategy to realize GNSS-based transportation infrastructure technology

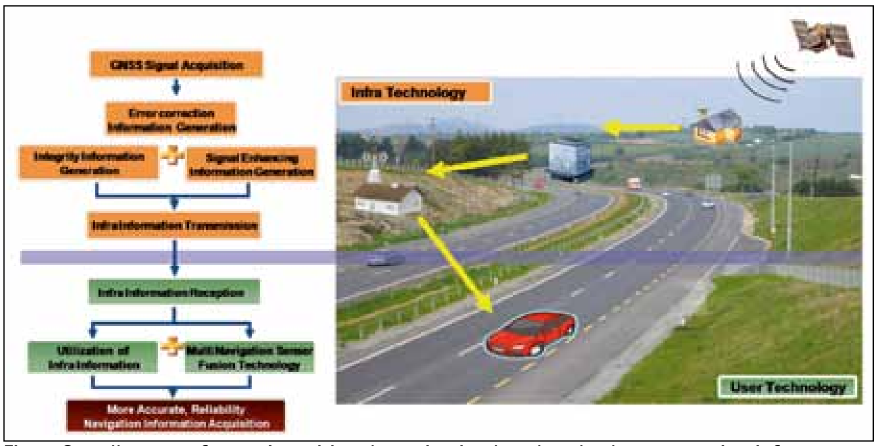

Fig 7. Overall process for user's position determination based on land transportation infrastructure technology

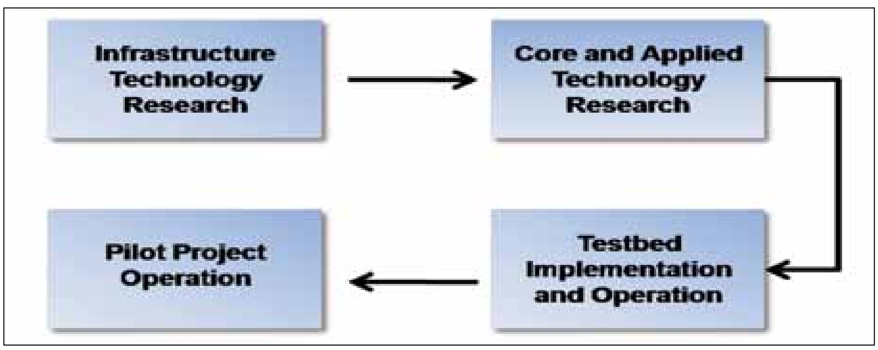

Fig 8. Leveled R&D strategy

Conclusion

The new GNSS-based transportation infrastructure can produce more accurate and reliable position information, to improve efficiency and safety, and can play a major role in future land transportation realizations such as Smart Highway, Ubiquitous Transportation and goods tracking. During the development process, various algorithms are explored, which will help advance related technology and secure technical advantage in the use of GNSS for land transportation. Unlike the use of GNSS for maritime or air transportation, its application to land transportation poses several limitations such as lower visibility and multi-paths stemming from ground obstacles. Overcoming these obstacles will lead to advantageous position in the related field. By standardizing new technology, Korea can secure a favorable status in the global market. Establishment of nation-wide transportation infrastructure with GNSS technology would facilitate development of the next-generation growth engines in areas of telematics and intelligent cars, creating a high-value market segment. In particular, new markets will emerge for installation of reference stations and production of user devices. An upgraded device will be able to provide new services such as vehicle operation record, or accident analysis, based on more accurate and reliable position information. This will lower risk of traffic accidents, eventually cutting back social cost through efficient transportation. In this research, current issues in developing GNSS-based land transportation infrastructure were examined, as a response to an emerging transportation system of tomorrow, and to improve safety and efficiency of land transportation. By standardizing related technologies, Korea will be able to acquire valuable core technologies in the global market, and also create new business markets.

Acknowledgement

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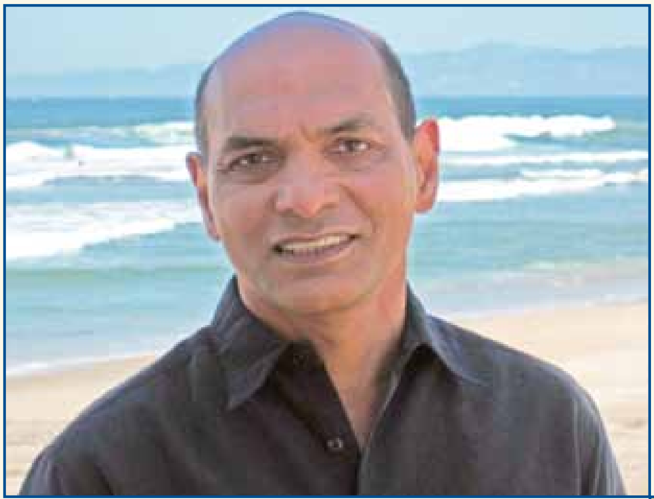
"It's hard to duplicate the success of turn-by-turn directions"

Says Sanjai Kohli, Father of Mass Market GPS and Inventor Extraordinaire



Congratulations on winning the European Inventor Award 2010 along with Steven Chen for your outstanding work on developing powerful chipsets. The GPS industry has already felt the impact of your invention, how do you feel about the recognition finally being accorded to you?

We knew that we had made an impact on the marketplace and the enormity of the change that was created was realized with this award. In addition to feelings of pride for being honoured for our efforts in enhancing GPS technology, it was especially rewarding to be recognized among such an esteemed group of pioneers by the European Commission and Patent Office – we all shared the common goal of advancing areas critical to human development.

Would you please share with our readers the incident that triggered the quest for the 'small' chip and the events that followed?

We were driving in downtown Tokyo in 1993 and realized that there was a huge potential for GPS navigation coupled with digital maps. While digital maps were available, GPS did not work in these kinds of urban areas due to signal blockages (e.g. tall buildings, foliage, RF interference, etc.). We really went about solving the urban operation problem of GPS, at a very low cost point. Today's embedded GPS solutions cost manufacturers just $1 for the HW and SW.

Do you think the use of GPS in our everyday lives would have grown to the extent that it has, even if the chips had not gotten 'smaller and cheaper'?

I believe the growth of GPS depended on more than just chips getting 'smaller and cheaper'. I think the first problem that had to be overcome in order to enable mass market use was to make GPS work more reliably. Without that, it wouldn't be accepted at any price point. I believe the cost is a function of the application. Consumers still pay $200-$300 for personal navigation devices and most car manufacturers still charge $1500-$2000 for an in-car navigation system. In contrast, Google gives you turn-by-turn directions free on your smart phone!

Recognized worldwide as the "Father of Mass Market GPS," Sanjai Kohli has for more than three decades been on the cutting edge of developing powerful hardware and software applications that increase the speed and precision of GPS technology now used commercially in cars, planes, ships and mobile phones. In April 2010, he was named "Inventor of the Year" by the European Union for his contribution to the success and mass popularity of GPS as we know it today. The award placed Mr. Kohli in the hall of distinguished winners whose ideas and innovations have made a tremendous impact on shaping the larger modern world.

What were the challenges you faced in developing and implementing your idea of a 'smaller and cheaper' GPS chip?

The challenges we encountered were beyond just creating and deploying a smaller and cheaper GPS chip. We had to change the way in which a spread spectrum system looks for, acquires and tracks signals. This capability then had to be embedded into a chip cheap enough for the consumer market.

We also introduced the concept of geometric constraints on the solution to operate on reduced degrees of freedom. Hence, the software that we supplied with our chips was equally important.

Could you please elaborate for our readers how the GPS chip technology you developed actually works?

The GPS chipsets we designed essentially "fill in the blanks" by pulling from alternative sources when satellite signals are down. This means that the system can continue to operate even with only one satellite in range.

By earlier standards, GPS systems determined a geographic position via satellite feedback and could only function accurately with as many as four in-range satellites. These systems were expensive and faced major limitations. For instance, if a single satellite's signal became blocked, the receivers failed to navigate. The new approach we took was to invent the physics of asynchronous signal processing to increase the signal processing power of a GPS chip over 1000-fold. This enabled the weakest of GPS signals to be found within milliseconds and paved the way for the use of handheld GPS navigators in urban environments.

Do you think the consumers in India are ready to use navigation technology?

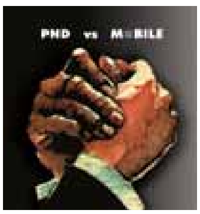
I think they are more than ready. It's hard finding your way in most major cities -- street names and street numbers are confusing, to say the least. I believe the tipping point for the Indian market is navigable maps.

Some countries have adopted car navigation in a big way already, which countries/region do you think will see the fastest growth in this segment in the coming months? And in your opinion what are the factors conducive for the adoption of this technology?

I think that car navigation is a given capability in most markets today, including China. It's a feature that is assumed to be either built into a car or in a PND or smart phone. For the markets which have not been penetrated, it's an issue with digital maps. The cost points are low enough for affordability in the Indian market, for example.

From improving the performance of GPS chips to increasing the yield of Solar Panels - that is quite a journey. Any plans to come back to the 'GPS application' fold?

We continue to look at new and exciting GPS applications for the mass market. However, it's hard to duplicate the success of turn-by-turn directions. That being said, we are examining some interesting mass market security applications.



PNDs and smartphone navigation both will have its place

The global smartphone market grew at exponential rates over the last years, and analysts predict very high growth in the years to come, indicating that these devices are making their way from a niche existence to mass adoption. Standard on most smartphones phones are GPS receivers, big screens and processing power that meets the standards of early laptops. These conditions are perfect for running GPS applications that turn smartphones into navigation systems. Smartphones even offer certain benefits that personal navigation devices (PNDs) do not. One example is the data connection which enables integrating live functions such as live traffic or weather updates without any extra costs into the navigation application.

Paid solutions with on-board maps, such as NAVIGON's MobileNavigator, also do not depend on the cell phone signal for navigation. Another benefit is that you don't have to carry an extra device and have navigation functionalities available without cell or internet service. NAVIGON's MobileNavigator also makes use of the digital compass built into the iPhone 3GS and 4, allowing for more precise pedestrian navigation.

But will navigation on smartphones make PNDs obsolete in the long run? While future predictions of this kind are always hard to make, this scenario is very unlikely. Both will have its place in the growing demand for GPS services, and they fulfill the different needs. Smartphone navigation apps are good for a wide variety of users, but they have to be seen as complimentary to a PND. Most users who need a GPS system in their main car and on a daily base will still prefer a PND. It's a technology that they know and are familiar with. A device that is designed for only one purpose, navigation, clearly has advantages over a multipurpose device. With screen sizes of up to five inches and higher, much better speakers as well as high-end 3D features that require a graphics accelerator, PNDs are still the best bet for those that navigate on a daily base. A Smartphone also has advantages, which make it perfect for other use cases. It is small and always with you, so you have navigation at hand all the time, for example when using a rental car. In urban areas, the pedestrian navigation comes in handy.

Looking at future developments, it is also important to point out that PNDs allow the manufacturers to develop software and hardware together. Enabling innovation of the two that combine both technologies to very unique and specific navigation functions, such as NAVIGON's Motion Sensor technology, which controls a navigation device by barely even touching it. On a smartphone, in comparison, navigation developers are restricted to what the manufacturers of the phones integrate into the hardware, limiting the development options for new features.

NAVIGON doesn't see the emerging market of smartphone navigation as a threat but rather an opportunity for additional market segments. We are utilizing our longstanding experience in developing navigation solutions to provide top-notch personal navigation devices as well as smartphone navigation apps.

Jörn Watzke
Vice President of Product Line Management, NAVIGON

Integration in a receiver position computation

This paper covers the different technical aspects of the integration in a receiver position computation of the observable data from several navigation constellations.

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Product Manager
Telespazio S.p.A.

Gian Paolo Plaia
System Engineer
Telespazio S.p.A.

The reference scenario is defined by a set of navigation systems; each system is composed by a set of signal generators (constellation) and by a common time reference. Each transmitter must be synchronized to the time base; this operation is performed using different algorithms in order to generate a time correction to be transmitted to the receiver.

This correction is then applied to each observable measure in order to refer the data to the common time reference.

When the data are acquired by different sets of transmitters they have different time references (for example GPS time, Galileo time, Compass time etc.) and therefore in the position computation the receiver must take into account a further unknown variable for each constellation, i.e. the difference among the different time references.

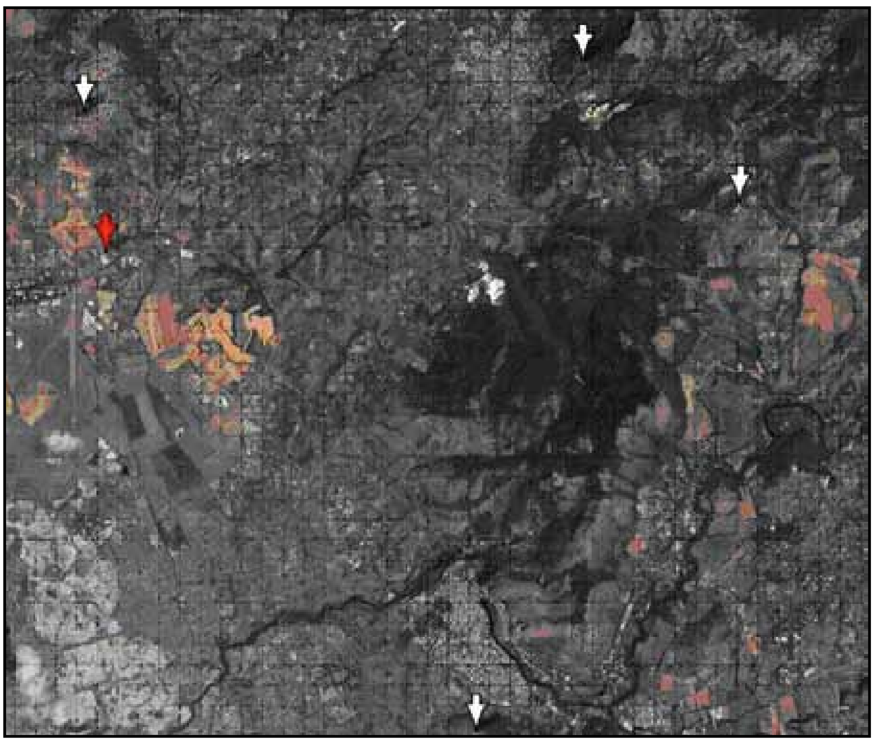

Fig1: Test Area – surroundings of Guidonia near Rome

In order to investigate the performance of the position computation when two constellations of transmitters are integrated, the performance parameters that characterize the geometric component of the error will be analyzed in simulated and real scenarios.

Brief introduction on the Diluition of Precision (DOP)

The DOP is a set of performance indexes that define a relation between the positioning performance and the geometric location of the transmitters.

For example the general expression that links the measurements error to the 4D user position accuracy is described by the GDOP (also called Geometric Diluition of Precision); the GDOP takes into account the three dimensional error plus the error in the computation of the receiver clock bias. As seen before considering the general problem of estimating the vector dX of 4 dimensions, given an observation vector $d\vec{\rho}$, the minimum variance unbiased estimate of X is given by:

$$d\vec{\rho} = \begin{pmatrix} d\rho_1 \\ d\rho_2 \\ d\rho_3 \\ d\rho_4 \end{pmatrix} = G\begin{pmatrix} dx \\ dy \\ dz \\ dt \end{pmatrix} + \begin{pmatrix} dn_1 \\ dn_2 \\ dn_3 \\ dn_4 \end{pmatrix} = Gd\vec{x} + dn$$

For uncorrelated measurement noise $\mathrm{cov}(\vec{n}) = \sigma^2 I$ and the estimate reduces to: $dX = P \cdot d\rho$

$$P = \left(G^T \cdot G\right)^{-1} \cdot G^T$$

Where P is the pseudoniverse of G.

We can obtain the GDOP expression from the computation of the covariance of the estimation x:

$$E\{d\vec{x}d\vec{x}'\} = \mathrm{cov}(\vec{x}) = E\{Pd\vec{n}d\vec{n}'P'\} =$$
$$= (G'G)^{-1}G'\,\mathrm{cov}(\vec{n})G(G'G)^{-1} = \left(G'G\right)^{-1}\sigma^2$$

Given:

$$\sigma_x^2 + \sigma_y^2 + \sigma_z^2 + \sigma_b^2 = tr(\mathrm{cov}(\vec{x})) =$$
$$= \frac{1}{|G|^2}\left(g_{11}^2 + g_{22}^2 + g_{33}^2 + g_{44}^2\right)$$

So GDOP=

$$\frac{1}{\sigma}\sqrt{\frac{1}{|G|^2}\left(g_{11}^2 + g_{22}^2 + g_{33}^2 + g_{44}^2\right)}$$

Given the previous expressions, in a more general way the DOP can be provided by the H matrix as follows:

$$H = \left(G^T \cdot G\right)^{-1}$$

$$\begin{bmatrix} H_{11} & H_{12} & H_{13} & H_{14} \\ \vdots & H_{22} & & \\ & \vdots & H_{33} & \vdots \\ H_{41} & H_{42} & \cdots & H_{44} \end{bmatrix}$$

The DOP matrix is directly linked to the covariance matrix of the optimal position estimator. The combination of the elements on the principal diagonal of the matrix H form the various DOP values. For example:

$$PDOP = \sqrt{\left(H_{11}{}^2 + H_{22}{}^2 + H_{33}{}^2\right)}$$
$$TDOP = H_{44}$$

A geometric interpretation of the GDOP is that GDOP reduces when the determinant of G is increasing, or when the volume of the geometric figure composed by the satellite positions used for the position estimation is increasing (infact G depends on the Azimuth and Elevation of each satellite in view).

The problem of the two constellations

Suppose that the two constellations have different time reference, there is a bias between the measurements coming from different transmitters.

The H matrix will have the following form:

$$H = \begin{bmatrix} H_{11} & H_{12} & H_{13} & H_{14} & H_{15} \\ \vdots & H_{22} & & \vdots & \vdots \\ \vdots & \vdots & H_{33} & & \vdots \\ \vdots & & \vdots & H_{44} & \vdots \\ H_{51} & H_{52} & \cdots & \cdots & H_{55} \end{bmatrix}$$

From the matrix H we can define DOP in the same way as before but including a new term: $TDOP_G$ the relative to the second time offset.

$$PDOP = \sqrt{\left(H_{11}{}^2 + H_{22}{}^2 + H_{33}{}^2\right)}$$
$$TDOP_G = H_{44}$$
$$TDOP = H_{55}$$

There are two different strategies to take into account the fifth unknown:

- using an estimation of the offset and then transmitted by a service centre, for example the Galileo Time Offset (GGTO) broadcast by GALILEO
- computing the offset directly into the receiver

In the first case the performance of the integrated system are the same of a single system composed by a number of transmitters equal to the sum of the two constellations, provided that the time synchronization offset is estimated apart and transmitted to the receiver.

By this way the receiver can solve the position problem using a state vector of four unknowns. In the second case, if the estimation is made at receiver level, two cases must be distinguished:

- Only one transmitter is belonging to the second constellation
- More than one transmitter is belonging to the second constellation

If one considers only one transmitter of the second constellation, the corresponding measure contributes only to the offset determination and not to the position computation.

In fact in this case, in the following is shown the column of the P matrix related to the measurement of the only transmitter (the fourth unknown is the bias between the two constellation, while the fifth is the first constellation bias w.r.t. the system time).

$$P(:,psl\ \ related\ \ col) = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \\ 1 \\ 0 \end{bmatrix}$$

So, independently to the number of transmitters of the first constellation, the measure obtained from the only transmitter of the second constellation will weight only the constellations bias solution, but not the position solution.

If we add more transmitters to the second constellation, from the P matrix it seems that all the measurements contribute to the position estimation.

It can be demonstrated that even if all the measurements are used to compute the position and the time offset, only above a certain number of transmitters used it is possible to have acceptable PDOP and TDOP values.

DOP computation with real measurement data

As a real scenario, measures of the GPS were integrated with the ones of another ranging source, simulating a configuration similar to the very first phase of the Galileo satellites deployment (In Orbit Validation phase - IOV).

During one of the integrations tests of the Gal ileo Test Range (GTR), located near Rome, we had the opportunity to collect measurement data from a constellation of four pseudolites and from the real GPS satellites.

So we had the opportunity to combine the measurement and define different integration scenarios like the simulated ones.

We considered the following combinations:

- Only GPS satellites, as a reference scenario
- One GPS satellite and four pseudolites
- Three GPS satellites and four pseudolites
- Five GPS satellites and four pseudolites
- All the visible GPS satellites and four pseudolites.

The elevation of the pseudolites is very low while the GPS are chosen starting from those which had the higher elevation.

The configuration of the pseudolites is shown in the figure 1:

The red arrow represents the reference receiver and the white arrows correspond to the pseudolites locations.

For the mixed position estimation problem the fifth unknown must introduced as detailed in the following.

The definition of pseudorange in terms of time interval between the transmission and reception of a signal is the following:

$$T_{Tx} = T_{Tx}^{true} + \Delta T_{Tx}$$

Where T_{Tx} is the time of transmission as reported by the satellite clock, T_{Tx}^{true} is the real time of transmission with reference to the Constellation time base (i.e. GPS Time).

ΔT_{Tx} is the offset between the satellite clock and the reference time.

For the receiver :

$$T_{Rx} = T_{Rx}^{true} + \Delta T_{Rx}$$

Where T_{Rx} is the time of reception as from the receiver clock, T_{Rx}^{true} is the real time of reception with reference to the Constellation time base, ΔT_{Rx} is the offset between the receiver clock and the reference time.

The real propagation time interval is:

$$\tau = T_{Rx}^{true} - T_{Tx}^{true}$$

The measured range is not c .t because of the time offsets, in fact:

$$\rho = c \cdot (T_{Rx} - T_{Tx})$$

$$= c \cdot (T_{Rx}^{true} + \Delta T_{Rx} - T_{Tx}^{true} - \Delta T_{Tx})$$

$$= c \cdot (T_{Tx}^{true} + \tau + \Delta T_{Rx} - T_{Tx}^{true} - \Delta T_{Tx})$$

$$= c \cdot (\tau + \Delta T_{Rx} - \Delta T_{Tx})$$

t is also affected by propagation "errors" which are added to the $T_{geometric}$ (that corresponds to the line of sight between the antenna of the receiver and the one of the satellite):

$$\tau = T_{iono} + T_{tropo} + T_{multipath} + T_{rel} + T_{geometric}$$

T_{rel} is due to the relativistic effects.

$T_{geometric}$ is R/c, with R geometric distance between the satellite and the receiver:

$$R = \sqrt{(x_S - x_u)^2 + (y_S - y_u)^2 + (z_S - z_u)^2}$$

Finally:

$$\rho = \sqrt{(x_S - x_u)^2 + (y_S - y_u)^2 + (z_S - z_u)^2} + c \cdot \left(\Delta T_{Rx} - \Delta T_{Tx} + T_{iono} + T_{tropo} + T_{multipath} + T_{rel}\right)$$

The unknowns are four, x,y,z and ΔT_{Rx}.

The other elements are approximated by models in order to get the best estimation of the "errors".

Considering a terrestrial transmitter like the one used in the simulations the equation that expresses the pseudorange is the same but with some remarks:

- ΔT_{Tx} and ΔT_{Rx} are offsets with respect to the GTR time, that is different from the GPS time.
- τ is defined as:

$$\tau = T_{tropo} + T_{multipath} + T_{geometric}$$

Because T_{iono} and T_{rel} are zero (they are significant only in the space).

The pseudorange is now:

$$\rho = \sqrt{(x_{PSL} - x_u)^2 + (y_{PSL} - y_u)^2 + (z_{PSL} - z_u)^2} + c \cdot \left(\Delta T_{Rx} - \Delta T_{Tx} + T_{tropo} + T_{multipath}\right)$$

ΔT_{Tx} like the GPS case is inserted in the navigation message of the pseudolite in the form of three parameters that allow the prediction of the correction in the future (8 minutes from the reception of the message).

When the two constellation are mixed, the system of equations must be modified in the following way.

The number of unknowns must be 5

- The receier coordinates;
- DTRx the offset between the receiver clock and the GPS time;
- DTGTR-GPS, the offset between the GTR time and the GPS time.

The easiest way is to change ΔT_{Rx} (referred to the GTR time) in the pseudolite equations with $\Delta T_{Rx} + \Delta T_{GTR\text{-}GPS}$. Now all ΔT_{Rx} in the system are referred to the GPS Time.

When we want to simulate the GGTO term like in the case of the integration between GALILEO and GPS, we have to estimate one of the bias terms in an independent way.

The simplest method was to solve the estimation position problem using all the GPS satellites in view with good DOP value (without the pseudolites) and then taking the result as ΔT_{Rx} to be used in the mixed system (GPS + Pseudolites).

So a first run of simulations was carried on using an a priori estimation of the bias between the two time scales, i.e. reducing the problem to a 4 unknowns least square problem. In the second run the offset is solved by the receiver itself.

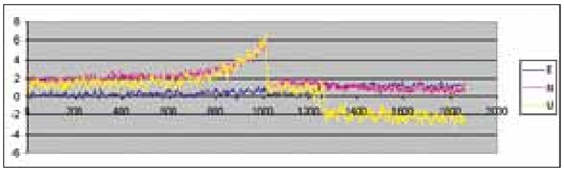

Fig 2: Only GPS satellites

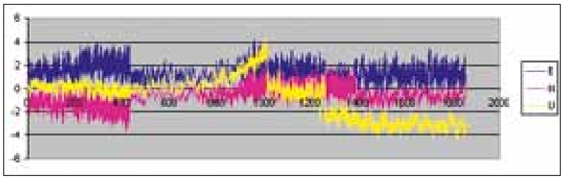

Fig 3: 3 GPS satellites plus pseudolites, system sync

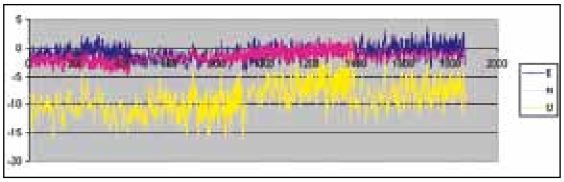

Fig 4: 3 GPS satellites plus pseudolites, autosync

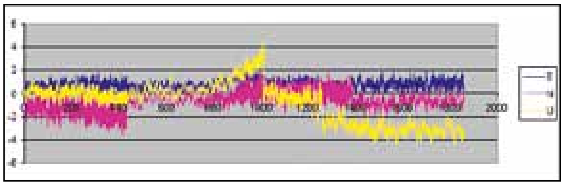

Fig 5: 5 GPS satellites plus pseudolites, system sync

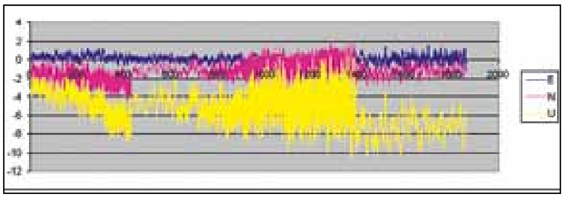

Fig 6: All GPS satellites plus pseudolites, system sync

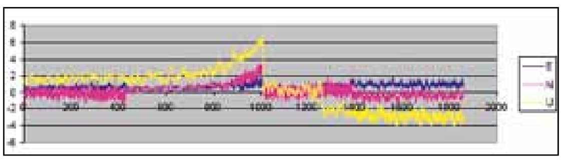

Fig 7: All GPS satellites plus pseudolites, autosync

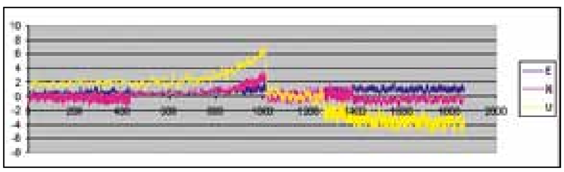

Fig 8

	No. Transmitters 12 (4+8)		No. Transmitters 9 (4+5)		No. Transmitters 7 (4 + 3)	
	System Sync	Autosync	System Sync	Autosync	System Sync	Autosync
PDOP	1,225	1,35	1,64	2,7	1,77	4
GDOP	1,6	1,66	2	3,0	2,21	5

Table 1: comparison of DOP values real signals

Simulation results

The simulations consider the PDOP and GDOP and the table below reports the number of transmitters (the first number is the Pseudolite constellation and the second the GPS one). A future version of the processing SW will also output the $TDOP_G$.

"Autosync" stands for the computation of the offset between the two time scales, while "System sync" stands for the procedure to compute the bias of one of the two constellations before the integration of all transmitters.

It can be noticed that the PDOP and GDOP values decrease when increasing the number of transmitters of the second constellation. The values of the H matrix belonging to the second constellation are firstly used to solve the synchronization (i.e. to decrease the TDOP and $TDOP_G$ terms) then, increasing the number of equations, they are used to get better performances of GDOP and PDOP.

When the bias is computed in an independent way, the performance are depending only on the number and geometric positions of the transmitters (all the equations contribute in the same way to all the DOP values).

So when observables from GPS and Galileo will be integrated at receiver level, it seems clear that the GGTO parameter contained into the Galileo navigation message will be a must. If obstructions (like urban canyons or indoor navigation) will avoid the reception of the navigation message, the GGTO will have to be sent through another communication channel (provided that the receiver is able to acquire enough satellites to get an acceptable DOP).

The same configurations have been used to compute the position of the receiver with the integrated constellation.

The first run, figure 3 has been carried on with only GPS satellites in order to establish the reference positioning performance (horizontal, towards east and north and vertical accuracy in a topocentric coordinates system). Positioning error is limited in 4 meters around the reference position (obtained through RTK differential corrections sent by the Telespazio GNSS Differential Station).

In the next runs, figures, 3 to 8, the comparison between the System sync and autosync scenarios is reported, in the configurations of 3, 5, all GPS satellites in view plus the pseudolites.

The performance improves with the increasing of GPS satellites in the same way as seen in the table of PDOP and GDOP.

In the last run, figure 7-8, the performance between the autosync and system sync scenarios is very similar, confirmed by the similarity between the DOP values.

Conclusions

The variance of the position error is comparable to the mean error, this is due to the noise in the receiver GPS bias estimation. Infact the bias is computed every second using Least Squares method as seen in the first paragraph; filtering the bias could give better performance to the position computation.

The DOP values depends on the positions of the transmitters with respect to the receiver location. As said before the DOP lowest value can be obtained in the middle of the constellation (in the middle of a tetraedric geometric form with the transmitters in the vertexes)

In the real configuration it was not possible to reach the optimal configuration (the GTR pseudolites are on the top of the surrounding hills and at different heights). The lowest value is found in the middle of the base of geometric figure formed by four pseudolites in the base and 7 satellites at the vertexes.

Finally the use of more constellations is useful only if the offsets are preliminary known. Moreover if one of the constellation is formed by pseudolites it is clear that their synchronization is very critical and that a modification is required in the firmware of currently available receivers to be used as an augmentation system because of the necessity to decode the particular navigation message.

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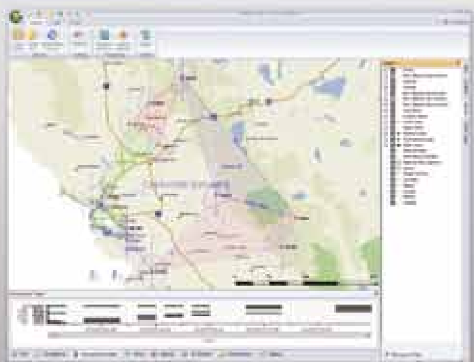

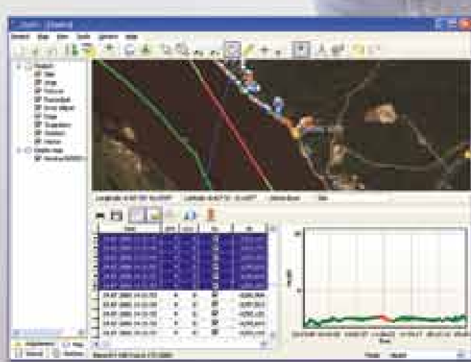

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I founded Ashtech and in 1989 we introduced the first All-in-One, All-in-View 12-channel Ashtech L-12 GPS receiver, followed by Ashtech Z-12. These were the first truly portable geodetic receivers. We were also the first to integrate GPS and GLONASS satellites.

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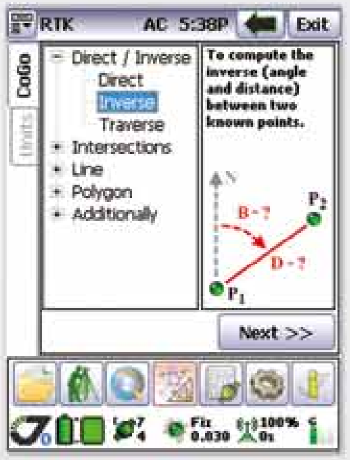

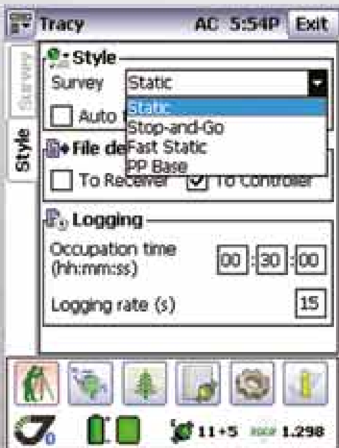

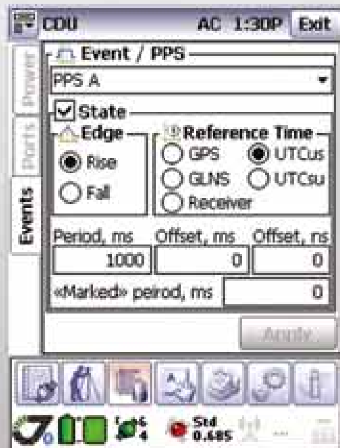

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Need for comprehensive urban information system

A model proposal for development authorities

Prof P Misra
Consultant, Land information technologies

The need – environment of an Urban Information System has undergone a sea change over the last few years. Couple of years back the requirements of information system was designed and projected primarily from the planners community. They were satisfied if the physical information was supplied on a scale of 1:5000/1:10000.

Presently the demands are coming from urban engineers involved in detailed design of water supply and sewerage systems, traffic and transportation (including fire and police), electricity and power and revenue authorities that are concerned with the land/property related matters. Comparatively new entrants are the professionals from the telecommunications (diggers for fibre cables) and other utility-infrastructure personnel who have started looking at the third dimension of the town (heights of buildings) for mobile cell communications. There are hosts of other users who need accurate urban information.

Need/Function	Scale	Height/Contour interval (Mts)	Remarks
Planning: Master Plan/ structure Zoning plans	1:4000 to 1:5000	2 to 5 mts	Legal Document
Engineering plans	1:2000 to 1:4000	0.5 metres/2m bench marks	Frequent revision
Housing plans	1:1000 to 1:4000	-------do------	
Water supply, Sewerage	1:1000 to 1:2000	spot heights + bench mark	
Traffic junction plans	1:1000 to 1:2000		
Transportation Routes	1:5000 to 1:10000	2 mts	
Road & Highways	1:2000 to 1:10000	1 mt	
Regulatory functions			
Revenue Authorities	1:1000 to 1:4000	-	Checking encroachments property matters
Unauthorized 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 Large Scale 1:10000 to 1:20000		

Table –I

The upshot of all the above information is that the Urban Information System (UIS) which is being designed in 2010 must cater to all the future requirements which should be presented in the most user friendly manner. This is the main genesis of the present day GIS hence the title of Comprehensive Urban Information System.

What is mentioned above is the perspective of the proposed detailed design and the contents of the proposal have been influenced by the factors enunciated in the following paragraphs.

Requirements and scale matrix of different users

The table below indicates the needs/ functions in terms of the scale of maps and information on elevations. For digital maps the scale depicts the density of information and the inherent accuracy linked with that scale.

Determination of scale, elevation and contents of database

A glance at the above table clearly indicates that the design of database should cater to the present and future needs of the various stakeholders (users) of the database. This database should also take care of the various 'attributes' as defined in the technology of Geographic Information System (GIS). For example in housing function, apart from the spatial location of the housing, the ownership, tax status, number of inhabitants, usage (residential/commercial), etc should also be stored in the database for the benefit of the end user of GIS.

It is very evident that all the required information need not be built as one project. The urban database can be designed on the 'evolved' basis. The priority information needed by most of the users can be collected first. The remaining information and attributes can be acquired in a phased manner. This direction of thinking has led us to first create the essential information through proper aerial photography field work surveys for ground controls and photogrammetry which will act as a foundation to link any other spatial information to be collected in subsequent phases.

Objectives of the Proposal

To establish computer based (digital) database for the area covered by development authority utilizing the modern technologies of:

- Aerial photogra
- Photogrammetry; Orthophoto and stereo restitution
- Geographic Information System and Satellite Imagery

To design the information retrieval system which is friendly to the functioning departments who will utilize the database. To keep database updated to the time cycle of 4-6 months.

To provide a link to the people by establishing information – kiosks, where the general public could obtain information of their interest like hotels, hospitals, milk booth etc. through the use of internet.

Technical proposal

Methodology

In particular, we propose to use aerial photography a well proven technology of photogrammetry which is productively and commercially being utilized for many urban projects. The other technology of Global Positioning System etc. will support the preparation of digital database and the processing of photogrammetry. The basic steps involved in the above methodology would be:

- Orthophoto

It is proposed that the whole of development authority and 2.kms on all sides should be covered with aerial photography on scale of 1:8000. this will form the input for generation of orthophoto. The above scale has been selected in order to produce accurate base –maps of up to 1:2000 scale. These base maps can also be utilized for cadastral purposes.

- Urban vector maps

  Development authority will be interested in almost all the physical features. Keeping this in view a scale of 1:8000 for aerial photography is proposed as optimum which will be used for producing 1:2000 scale vector maps. The security clearance from the Ministry of Defence will be taken by National Remote Sensing Centre, Hyderabad (NRSC).

  All the aerial photographs will be processed in NRSC photogrammetric processing laboratories where negatives/diapositives and contact prints will be prepared. The scanning of images will be carried out on high precision (up to 7-14 microns resolution) photogrammetric scanner for subsequent orthophoto generation and vector mapping in digital / analytical photogrammetric instruments.

- Quality control & Quality Assurance

  NRSC have an internal quality assurance plan that guarantees a final product comparable to international standards. The quality objectives are as follows:
  -that the quality of products and consultancies satisfies the expectations of the client as stipulated in the contract the specifications and the technical standards.
  -to deliver elegant reliable products in a format optimal for the client
  -high quality and minimum cost

- smallest size of ground object on aerial photography

  Taking 20 microns (1 micron=1mm/1000) as the resultant resolution of aerial negative; the minimum size of object on the ground which will be visible is.
  20 (microns) X 8000 (scale)
  =160 mm or 16 cms on orthophoto.

  It means that most of the distinct manholes will be visible on the aerial photograph.

  The aerial photography for whole area of development authority at 1:8000 scale for urban areas will be delivered through National Remote Sensing Center (NRSC), Hyderabad who will liaise with the concerned development authority for obtaining necessary flying clearances.

  It, therefore, implies that project formulation sanctions, etc. should finish well before start of good photographic flight season.

  The modern camera which NRSC uses is fitted with Global Positioning System (GPS) and Image Motion Compensation (IMC) device. This entails significant reduction of field control and improves the quality of aerial photography. The quality of aerial photography will adhere to world contemporary level.

- Ground control for photogrammetric process

  Photogrammetry stipulates a minimum number of ground control points at proper location with respect to the incidence of aerial photographs (model) on the ground. These ground control points are marked very accurately on the aerial photographs and form the first and most important input to the process of photogrammetry.

Pre-pointing/signalization of ground control points

As mentioned earlier the ground control points form the first input to photogrammetry. In that, these control points are used to orient the aerial photographic model (stereoscopic model) for scale elevation and accuracy. We wish to identify some ground points in the town which are

identifiable on aerial photographs. The special requirements, if any, by users agencies for identifying certain fixed points can also be taken care of.

Accuracy standards to be followed

Generally the photography is covered in strips with 60% overlap in the fore and off and 20% as the side overlap in near square or rectangular blocks. The requirement of the ground control is based on the photographic coverage of the each block.

- Photogrammetric accuracy & contour intervals

  Planimetric The requirement of Planimetric accuracy is generally met in photogrammetric plotting and is seldom critical. An accuracy of 20 cm in plan can be expected on 1:8000 scale photography. However, the mean square error in planimetry i.e. no more than 10% of points should have errors more than 0.25 mm on the scale of mapping will be adhered to.

  Contours Generally accepted tolerance is that only 10% of all check points may have an error large than half the contour interval. Maximum error in height of the control points that should be expected is 1/5th of contour interval and that is 20 cm for 1 meter interval.

- Aerial triangulation and photogrammetric plotting / mapping

  This is a photogrammetric operation in which initial field control (as mentioned earlier) is augmented by a set of procedures on photogrammetric instruments. The result is that the photographs (stereo models) will have control points at optimum places. These control points obtained after aerial triangulations are used for automatic orientation of models in analytical / digital photogrammetric instruments before carrying out photogrammetric plotting/mapping.

The digitization of all the physical details of the map and elevation is done mechanically while plotting. Thus in present day photogrammetry and machines available with NRSC and other agencies, the map output can be obtained as hard copy as well as in digital form.

It is quite possible to generate digital terrain model (DTM) for subsequent generation of orthophoto and input to GIS. NRSC etc. have state – of – the art photogrammetric equipment with adequate manpower which can be in operation round the clock..

Monumentation of ground control points:

It is the normal practice to provide some permanent pillars (X,Y,& Z co-ordinates) at suitable places in the city which not only will help in the model but will be most valuable for any future references. These references have a tendency to come up in land oriented legal disputes. The permanent pillars also are ideally useful for location of engineering projects on the ground.

A suitable design on the survey pillar appropriate to the city and the location of the pillar will be evolved in consultation with the development authority.

The cost of construction etc of the pillars will be included in the proposal

Urban Digital Orthophoto

Orthophoto by definition is an aerial photograph, which has been scaled and does not have geometric distortions (tilt and relief distortions). Photogrammetric process is carried to the stage of Aerial Triangulation which then helps in framing the digital terrain model of the overlapping photographs (model). The DTM generation will be carried out in two phases. In phase I, the automatic terrain extraction will be processed which will be followed by manual editing to incorporate the break lines and rectifying the inconsistency of contours to fit the terrain. The resultant DTM is made as an input to generate dimensionally accurate orthophoto.

Digital Database – contents and format

Database will have the following information, the list is just suggestive and can be modified as per the requirements of development authority.

a. **Physical Information**
   All topographical features subject to the scale of 1:1000, contours at 1 metre contour interval, spot height at 100 meter grid, ground control and GPS stations.

b. **Building**
   Building roof, Building, Heights of buildings especially high rise buildings, Industry/commercial area / Business sheds, Retaining Wall, Chimney, Brick Kiln, etc.

c. Road
Metalled/consolidated road, Unmetalled/unconsolidated road, Parking, Traffic Island / Boulevard, Traffic fence, Internal road, Road centre line, Road various/Path, Road Bridge

d. Drainage
Rivers (>3 mts wide-2 lines), Steams (<3 mts-single line), Edge of Drain/ Ditch, Bottom of Drain/Ditch, Canal Bed, Canal Bank, Well, Lake/ Pond/tank, Marshy land/Bogs

e. Physical Boundaries
Landuse boundaries, Fence, Hedge, Slope top, Slope bottom, Plantation Line, Garden, Forest Area, Rocking/ quarry area, Mining areas, Wasteland

f. Others
Power line, Poles, Electric/ Telephone poles, Transformers, High tension pylon, High tension line, Pylon base, Railway track, Telecommunication tower

g. Land Use Information
Type of soils, Ground water table, Water logged areas, Sport/ Golf course, Trees & Vegetation
- Mast

h. Slums and squatter areas

The roof area of the slum cluster with open spaces lane etc.

i. Water supply & sewerage (Based on local records)
Water supply lines, Manholes, Sewerage junction etc.

Note: the above list provides an idea about items which can be picked up by aerial photography. Similar objects can also be suggested by development authority.

Basic information attribute to be supplied by the development authority (not included in cost)

Socio-Economic Data
Plot ownership and other attributes, Property ownership and other attributes, Agricultural/villages inhabited area socio economic data will be collected/

Collated by local authorities for information

Boundaries (with pillars if any)
Urban ward, Defence land, Government land, Names of localities and important land marks

Any other information (attribute) desired by development authority

Revision and Updating of urban digital data

Preparation of Urban Information System will entail major efforts in generation of physical database. This is a common scenario in all developing countries as all the information required for GIS is not readily available. After the data base is prepared through the photogammetric process it will be incumbent on the authorities to update the data base. Major physical changes take place on the periphery of the town. Town will have a lot of changes in buildings roads parks drainage land –use and infrastructure and a host of underground utilities. It is therefore suggested that digital database should be kept updated with the help of field visits aerial photographs/high resolution satellite imagery and verification by ground surveying techniques.

Geographic information system

GIS is basically a comprehensive spatial decision support system based on (a) geo-referenced digital data base (b) computer hardware/software (c) non –spatial attribute data. Spatial data is obtained from satellite imagery aerial photography/photogrammetry field surveying and ground visits.

Today GIS can be applied conveniently for land suitability analysis landscaping land use modeling (forecast) environmental impact assessment of human settlements, urban growth, location allocation of utilities/facilities, traffic planning, air pollution studies and hazard studies etc.

Preparation of the digital database is 70-80% of total efforts for the establishment of the GIS. The digital data base once complete will be a big fillip towards establishment of GIS. A separate proposal meant for the establishment of GIS could be prepared.

Functions that development authority urban information would perform

It is our objective to establish an operational and dynamic urban information system which will be greatly facilitated not only by the generation of a detailed digital data base but also which can easily be accessed updated and analysed for different purpose. It is proposed that the geographical information system will cater the data requirements of all the departments within development authority. The provision of a common database and access to it by the various departments of planning, property, finance, engineering, industry, personnel and that of marketing and rural development will not only increase efficiency and productivity but also go a long way for future decision support system. With readily accessible and accurate information, the three broad functions of planning, revenue and that of engineering within the development authority would get streamlined. The detailed physical information contents of the database will have great utility to the various departments.

The section below indicates the possibilities that exist within each of the departments.

The engineering department would not only be able to have a complete grasp of the existing situation but also plan for the design of new roads and facilities. Detailed utility mapping showing the exact spatial location of the water supply lines, the sewage network, the telephone and electricity supply lines would go a long way in providing optimal services and increasing revenues. The detailed spatial database would also provide the ideal basis for the monitoring operations and maintenance of existing assets.

The planning department would require detailed land use maps which would not only help in the preparation of the new

master plan but also help in the process of monitoring. The contents of same database can be used to develop an approval system wherein the process of building / plan sanctions can be approved on – line or with minimal paper work.

With respect to revenue and cadastral management system the detailed base map can be used as a base to develop a monitoring mechanism with the details of the properties, their current value and the rate of taxation, etc. This will give a clearer understanding of the current status of properties related to their various aspects and thereby help in initiating processes for revenue collection.Once a detailed digital database is created the contents of this would be used to develop web-based application. The web based applications can not only be used to inform and interact with the public but also reduce paper work, increase efficiency and if necessary limit direct contact with the public to a minimum. In terms of streamlining internal procedures the contents of the database with linkages to the various functioning units within the authority would provide the ideal platform to develop a corporate information system for developing both monitoring mechanisms within the organization and also providing information to the public if required.

Map updation and maintenance system

A modern coordinated cadastral system requires regular maintenance. To keep the records up-to-date and without losing the reliability of data the cadastral maps have to be updated from time to time. A program of renovation would be required to be incorporated into the regular surveys replacing the coordinating points which are lost, disturbed or become invalid.

Land information technologies – regulating the city

Regular monitoring

Encroachment of government land and unauthorized construction are very much a common feature of any urban centre. By comparing the base maps of different epochs of time one can get the handle on the extent of encroachment and its location. The technology of producing the base – maps will be suitably designed to get authentic extent of the encroachment.

Environmental monitoring

This function in managing a city has recently gained a major dimension. The fact is that public perception of a city administration is judged mainly by the way environment is officially monitored. The agency will provide the following information about the city regarding environmental parameters: Inventory of all tress and vegetation (type location) as a Bench Mark study. Any subsequent change will be measured with respect to this Bench Mark Survey. Establishment of urban village boundary (Lal Dora) Village boundary determines the land –use of the urban village. This should be clearly established on the map in an unequivocal manner. The assistance of development authority will be requested in this regard.

Products and deliverables

Vector map of urban areas

- One set of Negatives, Diapositives and Contact Prints storage of these items, following the security norms of the Ministry of Defence can also be done by NRSC
- Digital vector maps
- Hard copies of maps of urban areas on scale of 1:2000 scale
- Field control data with description of monumented (pillars) stations

Other relevant records/notes

Orthophoto product

- Photographic copy of Orthophoto on 1:2000 / 1:5000 scale
- Digital ortho-photos (optional)
- Other relevant records/ notes

Training and Education

The users will be imparted training and education for effective operation and management of all the database maps and cadastral information. To achieve this a specially designed training program will be arranged for the staff of user departments for use and managing the systems. An estimated 50 staff from user departments will be arranged in GPS/Survey/Database training on a mutually agreed cost sharing basis.

Financial aspect of the proposal

(Pertains to preparation of digital data base for development authority)

The cost of the proposal will depend on the following:

- Technical activities
- The managerial decisions about the phases for the production and its strategy.

The technical activities have already been explained in the body of the proposal. Some explanation is however necessary to understand the production phases.

Strategy of production phases / scheduling of investment by development authority

Decision about these phases becomes important to reduce the budget allocation per year. For example aerial photography (which is not costly) should be ordered for the whole area of development authority. Similarly field control (GPS operations and leveling) is also essential for the whole area. Once these two items are done, the process of aerial triangulation can proceed in NRSC office.

After incurring this cost the decision by development authority can be taken to spread the cost of mapping to a longer period of more than one financial year by asking for photogrammetric mapping of only a small portion of the town. This is being suggested as the major cost of mapping lies in the photogrammetric plotting.

GPS IIIB Program progress

Lockheed Martin has successfully completed a key requirements review for the GPS IIIB satellite series under the U.S. Air Force's next generation GPS III Space Segment program. The team which also includes ITT and General Dynamics, recently completed a two-day GPS IIIB System Requirements Review (SRR). The successful review demonstrated to the customer and user community the Lockheed Martin team's understanding of the inherent product development and technology maturity risks, how they will be met, and the program's readiness to continue to the GPS IIIB System Design Review. The team, which is progressing in the GPS IIIA Critical Design Review (CDR) phase of the program, has completed more than 80% of the planned CDRs and is well on its path to the overall space vehicle CDR ahead of the planned schedule. *www.lockheedmartin.com*

Boeing GPS IIF-1 satellite active

Boeing has acquired the first on-orbit signals from the GPS IIF-1 satellite, the inaugural spacecraft in a 12-satellite constellation that the company is building for the U.S. Air Force. The signals indicate that the spacecraft bus is functioning normally and ready to begin orbital maneuvers and operational testing. GPS signals from the spacecraft payload will be turned on for test purposes in the coming weeks. The GPS IIF-1 satellite will undergo months of on-orbit tests, including functional testing of its payloads and end-to-end system testing to verify operability with older GPS satellites, ground receivers, and the ground control system. *www.boeing.com*

China sends Beidou satellite to orbit

China launched another satellite toward an orbit more than 22,000 miles above Earth, marking another step in building the country's own space navigation system. The satellite is the fourth spacecraft to be launched in the second-generation Beidou constellation. *http://spaceflightnow.com*

Tsunami Prediction System

A NASA-led research team has successfully demonstrated the elements of a prototype tsunami prediction system that quickly and accurately assesses large earthquakes and estimates the size of resulting tsunamis. A team led by Y. Tony Song of NASA's Jet Propulsion Laboratory in Pasadena, California, used real-time data from the agency's GDGPS network to successfully predict the size of the resulting tsunami. The network combines global and regional real-time data from hundreds of GPS sites and estimates their positions every second. It can detect ground motions as small as a few centimeters. *www.jpl.nasa.gov*

Limitations of Wireless 9-1-1 Calls

True Position announced the findings of a research study undertaken with Ovum. The research concludes that Public Safety Answering Points (PSAPs) who answer 9-1-1 wireless calls do not believe GPS works adequately in indoor and urban environments where the GPS signal, which requires a clear line of sight to the sky, is often obstructed by the steel and concrete of the buildings the cell phone caller is in or near. The PSAPs involved in the study believe accuracy, reliability and response time are critical to successfully processing 9-1-1 calls, yet only 10% believe that GPS meets their accuracy, reliability and response time needs and expectations in indoor and urban environments. Alarmingly, PSAPs in the study almost unanimously agreed that location information generated using GPS in dense urban areas is unreliable, and 9-1-1 call-takers often have to make multiple attempts to locate the caller. *www.trueposition.com*

NASA develops GenX search system

The Search and Rescue Mission Office at NASA's Goddard Space Flight Center, in collaboration with several government agencies, has developed a next-generation search and rescue system, called the Distress Alerting Satellite System (DASS). DASS will be able to almost instantaneously detect and locate distress signals generated by 406MHz beacons installed on aircraft and vessels or carried by individuals. The satellite-based instruments will be installed on the US military's GPS operating in mid-Earth orbit. *TG Daily*

NextGen GPS in aircrafts by 2020

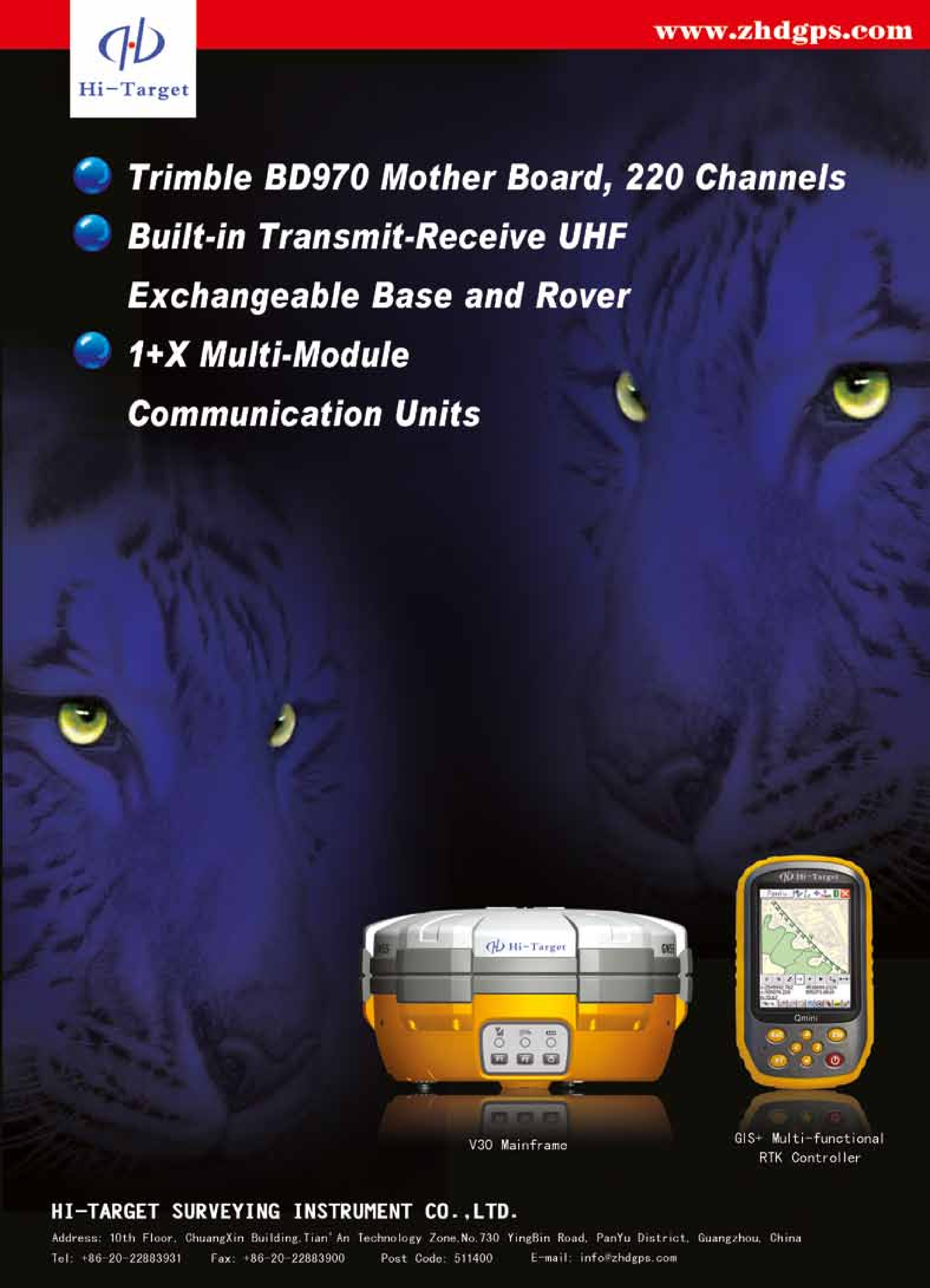
Aircrafts in the US are expected to be equipped with new global-positioning technology by 2020. The equipment, which could cost US airlines as much as USD 6.2 billion by some estimates to install in all aircrafts' cockpits, is a key element of the NextGen Air Traffic Control system that would replace the 1950s-era ground-based radar control system now in use. The system is supposed to improve safety, reduce air traffic congestion, increase traffic capacity, lower fuel consumption and shorten commercial flight times. *USA Today*

DGPS to aid Mumbai Metro

The Mumbai Metropolitan Region Development Authority (MMRDA) in India has allowed the use of DGPS to speed up the completion of the second corridor of Mumbai Metro. Estimated to cost Rs 8,250 crore, the contract has been awarded to a consortium led by Reliance Infrastructure (RInfra). DGPS will ensure the probability of the error is minimal as it will have exceptional accuracy and ensure smooth completion of the project. RInfra has roped in Fugro, who will co-ordinate and map the entire 32-km stretch.*http://economictimes.indiatimes.com*

Encyclopaedia Britannica loses suit

Garmin Ltd. and Toyota Motor Corp. were among seven companies that defeated patent-infringement claims filed by Encyclopaedia Britannica Inc. over digital maps. Two patents owned by the research publisher are invalid, the U.S. Court of Appeals for the Federal Circuit said. The decision upholds a lower-court ruling that the patents covered ideas that were publicly known more than a year before the date of the Encyclopaedia Britannica inventions. nda Motor Co. *www.kansascity.com*


Hi-Target
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GIS+ Multi-functional
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At a Glance

- Trimble announced the acquisition of Definiens' Earth Sciences business assets and licensing of its software technology platform in an all-cash transaction.
- Optech Incorporated announced that it has acquired the operations and assets of DiMAC sprl, inventor of the patented DiMAC true Forward Motion Compensation technology.
- Topcon Positioning Systems (TPS) has acquired InlandGEO.
- Intermap Technologies and JBA Consulting have announced a strategic collaboration to provide detailed flood mapping services for clients across Continental Europe.
- Russian wireless operator MTS is set to launch a turn-by turn navigation solution powered by Telmap across its portfolio of GPS-enabled phones.
- RapidEye announced that Panaxx Corporation will be its distributor in Japan.
- Aslanlar Insatt has chosen the Ashtech ProMark™ 500 GNSS receiver to meet its GNSS survey needs.
- DigitalGlobe announced an agreement with the National Geospatial-Intelligence Agency (NGA), U.S. for use of DigitalGlobe's Crisis Event Service (CES) for a 12-month term.
- China Information Security Technology announced that it has signed a contract valued at approximately US$5 million, to provide an intelligent traffic management system for the 16th Asian Games to be held in Guangzhou, China.
- A legislation was introduced to establish a statewide geospatial coordination council, in Pennsylvania, USA.

Galileo update

RUAG Space selected to provide equipment for Galileo satellites

RUAG Space has been selected to supply components worth a total of approximately 35 million Euros to equip 14 satellites in the European Galileo navigation program. In addition to the central control computers and further electronic components, RUAG Space will also be responsible for manufacturing alignment mechanisms for the satellite's solar arrays, as well as antennas and a special multi-layer insulation blanket.

"Participation in the Galileo project not only represents a major business deal for RUAG but also confirms the strategic direction being taken by our Space division," explained Peter Guggenbach, CEO RUAG Space. "We have gathered a number of different niche space suppliers under the RUAG umbrella. As Europe's largest independent supplier, we are now able to offer a comprehensive product portfolio," added Guggenbach.The central control computers for the Galileo satellites will be manufactured by RUAG Space in Gothenburg, Sweden. These computers are designed to control and monitor the navigation payload and numerous other subsystems. They will also control the temperature and power distribution onboard the satellites. RUAG Space Austria is also involved in the process of developing and building these computers. *www.ruag.com*

Jean-Jacques Dordain to continue as Director General of ESA

The Council of the ESA announced that Jean-Jacques Dordain will continue as the Director General of ESA for a further period of four years. Mr Dordain has served as Director General of ESA since 2003. This third mandate extends his term to June 2015. *www.esa.int*

EU sees opportunities for space applications

The European Commission's recently adopted GNSS Applications Action Plan aims to place European industry in pole position to take full advantage of the global downstream market worth about €100 billion in particular by using its own satellite navigation programmes, Galileo and EGNOS. Significant commercial and research opportunities are available to universities, developers and manufacturers in Europe to research, innovate, develop or sell applications based on this sophisticated technology.

Antonio Tajani, European Commission Vice-President in charge of Industry and Entrepreneurship, said: "Europe simply cannot afford to ignore the economic benefits of taking full advantage of this market – the alternative is not an option. Action must be taken to ensure Europe's SMEs become aware of the extensive business opportunities and the European citizens about the vast variety of possible applications. Like the Internet, satellite applications will play a part in all our daily lives." The uptake of GNSS applications in Europe has until now been slow notwithstanding Europe's investments and the availability of EGNOS. The share of the European industry in worldwide GNSS applications market is moreover low. The limited usage of applications based on EGNOS and GALILEO leads to critical dependencies from military-inspired GNSS that are beyond European control. *www.eurasiareview.com*

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Laser Plummet (optional)

2”or 5”
Measuring range without prism: 300m
Accuracy: 5mm+3ppm
Measuring range with single prism: 5000m
Accuracy: 2mm+2ppm

Indian Cabinet approves national policy on data sharing

The Union Cabinet, at a meeting chaired by the Prime Minister approved the National Policy on Data Sharing which enables making such information available in the public domain. However, the general public may not get access to any spatial data of choice. Union Ministries will be asked to identify data that can be made available in the public domain through the Right to Information Act. "Lists will be prepared of items that could be shared and such lists will be reviewed periodically," Min of I&B said. Department of Science and Technology has been appointed as the nodal agency for coordination with ministries. It will also work on a pricing policy to decide on the charges to be levied on information accessed by the public. *Press Trust of India*

Pitney Bowes MapInfo Professional v10.5

Pitney Bowes has released MapInfo Professional® v10.5, the latest version of the company's flagship application for business and mapping analysis. *www.pbinsight.com*

Delhi joins cities with utilities on digital format

Under the Delhi State Spatial Data Infrastructure (DSSDI) project, all the underground as well as overground utilities in the city were mapped using state-of-art technology and they will now be made available to almost 30 departments of city government through a specially created portal. *www.ptinews.com*

ESRI ArcGIS Server as a Cloud-Based Subscription, ArcGIS.com launched

ESRI customers will now have the option to purchase a cloud-based subscription to ArcGIS Server, With this option, users can purchase an annual subscription, which bundles a preconfigured ArcGIS Server instance on Amazon's Elastic Compute Cloud (EC2) infrastructure with 12 months of technical support and maintenance. ArcGIS.com helps finding and sharing GIS content, organizing geographic information into groups, and building communities. Visitors can access a number of free, ready-to-use basemaps for their projects and applications, including community maps that have been built with data from organizations around the world. *www.esri.com*

USGS accelerates access to maps in Oil Spill area

To assist in responding to the Deepwater Horizon oil spill, the U.S. Geological Survey has developed a new tool to rapidly distribute the latest USGS topographic maps of the Gulf Coast region. The experts have created the Emergency Response Map Index Tool (ERMIT), an event-specific application that provides quick access to standard USGS mapping products from a standard DVD. Access to the internet is not required, saving download time and disk storage. When loaded to any PC computer, the tool displays an index of pre-loaded maps. *http://nationalmap.gov*

Great Britain's "fraud landscape"

OS OpenData, Ordnance Survey's mapping and data portal, allows banks and insurance firms free access to key geographic datasets for the first time. When used with an organisation's own fraud intelligence, changes in the frequency or the location of patterns are then much clearer. To demonstrate the potential, OS has created a series of "fraud maps" that match statistics from a leading industry body to their geographic locations. *www.ordnancesurvey.co.uk*

WebGIS applied to Traffic Impact Assessment

The Institute of Transportation MOTC, Taiwan, plans to predict and improve traffic impacts on land development by a GIS platform. The project utilizes SuperWebGIS, and aims to maintain and update the image data, traffic basic information, traffic parameter, laws and regulations and assessment cases to assist the related staffs in effectively assessing traffic impacts caused by land development. *www.supergeotek.com*

UKHO completes official ENC coverage of China

The United Kingdom Hydrographic Office (UKHO) has completed the Chinese coastal coverage; another substantial increase in the Electronic Navigation Charts (ENC) available in its Admiralty Vector Chart Service. The new charts are being made available under a unique agreement between the UKHO and the Chinese Naval Guarantee Department (NGD). *www.ukho.gov.uk*

UN unveils campaign to make cities more resistant to disasters

With the recent wave of natural hazards exposing the need for cities to implement disaster reduction plans, the UN is launching a campaign to boost the resiliency of urban areas. The two-year scheme, called Making Cities Resilient: My City is Getting Ready, calls on leaders and local governments to commit to a 10-point checklist. The campaign seeks to bring more than 1,000 local government leaders around the world to step up their investment in urban planning; infrastructure and building safety; reinforcing drainage systems to reduce flooding; and installing early warning systems, among other measures. The new campaign also urges community groups, planners, academics, NGOs and the private sector to join efforts to enhance the resiliency of cities.

SITECH technology dealers in India

Trimble announced that SITECH™ India North & East and SITECH India South & West have been established to serve heavy and highway contractors in India. They will represent Trimble® and Caterpillar® machine control systems for the contractor's entire fleet of heavy equipment regardless of machine brand, along with Trimble's portfolio of Connected Site™ solutions. *www.trimble.com*

South Korean launch fails

The Korea Space Launch Vehicle 1 is thought to have blown up soon after take-off. The launch was South Korea's second attempt to put a satellite in space, after a launch in August 2009 failed. *http://news.bbc.co.uk*

Commercial Airport Mapping Database by GeoEye

GeoEye has delivered the first commercial high-resolution airport database of Kuala Lumpur International Airport to Malaysia Airport Holdings Berhad's Technical Services Division (MAHB). This product meets the new ICAOs Area-2 and Area-3 reporting requirements and uses IKONOS colour stereo imagery to create 3D models of the airport, terrain and any flight safety obstacles. *www.geoeye.com*

Pictometry imagery for Haiti

Pictometry International aerial oblique imagery of the earthquake damage in Haiti is being used by the International Council on Monuments and Sites (ICOMOS) to help strengthen Haiti's devastated economic base by preserving cultural locations for tourism and commerce. Volunteers scan historic maps from the eighteenth and nineteenth centuries then overlay the maps on imagery to locate the footprint of a structure on a historic map and match damaged structures to those on the images. Locations are then tagged as a potential historic site and are examined in greater detail. *www.pictometry.com*

Aerial survey of London in a day

New aerial photography survey of London was completed in just one day. Previous air surveys of London have taken up to 3 years to complete due to weather and complexities of air traffic restrictions across one of the busiest air spaces in the world. The GeoInformation Group, along with its flying partner Aerodata International Surveys, was able to survey and collect over 4500 images across London in one flight. These images are geographically accurate and will be processed into one seamless, map accurate, image database. *www.citiesrevealed.com*

RapidEye Library expands

RapidEye announced that satellite imagery of over 95% of India is now available in the RapidEye Library. Much of the country has been collected cloud-free, with the remainder containing less than 10% cloud cover. *www.rapideye.de*

TerraSAR-X ELEVATION product

Infoterra GmbH has announced the first element of its TerraSAR-X ELEVATION product suite. Featuring a 10m grid spacing and an absolute height accuracy of up to 5m, the TerraSAR-X ELEVATION DSM is now operationally available for areas as small as only 500 sqkm, and up to full regional coverage, worldwide. *www.infoterra.de*

TanDEM-X satellite launched

The TanDEM-X, twin satellite to TerraSAR-X, was launched successfully from Baikonur in Kazachstan. Together, the two satellites will spend three years collecting stereo radar data for a global digital elevation model of the Earth's entire landmass. This DEM will feature a global homogeneity and a relative accuracy of better than 2 m (10 m absolute) for a 12 m grid. Infoterra will be conducting the commercial marketing of this DEM. *www.infoterra.de*

CARIS announces Bathy Database 3.0

CARIS released Bathy DataBASE 3.0, built on the CSAR Framework that provides support for the display and manipulation of billions of points in both 2D and 3D. It now supports the USGS grid format data and also allows its bathymetry to be easily exported to KMZ for display in Google Earth. This release also provides improved land and sea data integration allowing topographic DEMs to be seamless combined and managed with bathymetric surfaces. *www.caris.com*

Nokia and CE4A release Terminal Mode Specs

Nokia and CE4A (Consumer Electronics for Automotive) working group have released the Terminal Mode technology specification as a proposed industry standard for the integration of mobile applications into the car environment. The German CE4A group includes Audi, BMW, Daimler, Porsche and Volkswagen. Once connected, the full range of smartphone features, services and applications can be made available through screens and audio systems embedded in the car. *www.nokia.com*

CSR ships SiRFatlasV

CSR announced the SiRFatlasV multifunction GPS system processor to power cost-effective consumer navigation systems. It combines on a single chip a 500- or 664-MHz ARM11 processor core with vector floating point unit; advanced, autonomous GPS/Galileo baseband DSP core with available SiRFAlwaysFix™ technology etc. *www.csr.com*

New iPhone App can prevent crime

The primary purpose of the new iPhone application IcePics (In Case of Emergency Pictures), is to assist anyone who suspects they are about to become a victim of kidnapping, rape, robbery or assault by having then simply point their iPhone at the suspicious person and push the IcePics button on their iPhone. IcePics will email a picture of the bad guy along with the GPS location of that photo right away to contacts pre-selected by the owner. *www.IcePics.com*

Aplicom's advanced Vehicle telematics device

Aplicom has launched a vehicle telematics unit combining GPS and GLONASS positioning systems. It has more satellites available to it than a device only connecting to either positioning system. It also supports A-GNSS. *www.aplicom.com*

Leica releases MobileMatriX 4.0, updates GMX902 family

Leica MobileMatriX 4.0 supports the new Leica Viva GNSS series, as well as L1 and L1/L2 Post-Processing, Microsoft Windows 7 and many other improvements. It is an advanced solution for mobile GIS applications in combination with GNSS, Total Stations, Levels, Digital Cameras, and Laser Range Finders.

The GMX902 GNSS enhances the product offering by adding 50Hz data rate, triple frequency and Galileo tracking. It has been updated with high speed serial ports and even lower power consumption than before. It is ideal for monitoring vibrations and movements of a wide variety of structures including bridges, high rise buildings, dams, landslides and more. *www.leica-geosystems.com*

Bentley integrates products, releases MXROAD and MXROAD Suite

Bentley Systems has integrated its civil engineering design and stormwater modeling and analysis applications to further enhance workflows and facilitate collaboration. It includes InRoads, GEOPAK, PowerCivil for North America, MXROAD, CivilStorm, StormCAD, and PondPack products.

It has also announced the immediate availability of the V8i (SELECTseries 1) versions of Bentley MXROAD and MXROAD Suite – both of which provide advanced string-based modeling that enables the rapid and accurate design of all road types. The new releases also add a full-featured geospatial information management system *www.bentley.com*

New GPS/GLONASS Helical antenna

Maxtena has released the M1516HCT Helical GPS/GLONASS Antenna. It is a low profile professional-grade GNSS antenna covering the GPS L1, GLONASS L1 frequency band. It is the worlds' first Helical GPS/GLONASS low profile precision antenna. *www.maxtena.com*

NovAtel Adds New IMU to its SPAN™ GNSS/INS Product Line

NovAtel Inc. recently released the latest product in its GNSS/INS SPAN product family, the IMU-LCI. It contains a Northrop Grumman sensor that provides the low noise and stability required for applications requiring precise positioning and attitude. Coordinates caught up with Mr Jason Hamilton Product Manager, SPAN group and Waypoint Products Group at NovAtel to know more about this

Would you please elaborate on the 'low noise and stability' of the new sensor that the IMU-LCI contains?

Closed-loop FOGs like those contained within the IMU-LCI have excellent noise and stability characteristics. The FOG random walk is quite low and the performance over temperature is also very stable. The micromechanical accelerometers are calibrated to provide stable bias over temperature. As a result, when this sensor is used in a SPAN system, the attitude accuracy is in-line with what we observe with the LN200 IMU.

Why is the IMU-LCI an 'excellent choice for airborne and ground survey applications'?

There are multiple characteristics of the sensor that make it a good candidate for survey applications. The stable gyro and accel sensor biases limit the amount of solution drift during GNSS outage periods. The low noise gyros result in low error growth during periods of stable dynamics like flight lines. The high bandwidth of the sensors make them suitable for high data-rate applications like LiDAR and can mitigate negative navigation artifacts sometimes seen in high-vibration environments like ground mobile or helicopter applications. When combined in a tightly-coupled solution within SPAN, the product offers excellent position and orientation accuracy required by airborne applications and stable bridging of partial and full GNSS outages required for ground mapping.

Can you please name few other applications where the IMU-LCI can be used?

The IMU, as part of a NovAtel SPAN GNSS/INS system, is suitable for almost any application that requires stable position and accurate attitude output. The IMU is environmentally sealed, so it offers flexibility for a range of installations. The optional odometer input in SPAN enables improved accuracy in ground applications like ground-based LIDAR, mapping, image collection or vehicle positioning and navigation. The dual-antenna solution available when integrated with the SPAN-SE receiver enables marine applications like hydrographic surveying and low dynamic applications like rail monitoring.

Hemisphere GPS introduces new products

Hemisphere GPS has released Crescent Vector II OEM board and a broad range of Crescent Vector II GPS compass products: V101 Series, VS101 Series, and LV101 OEM board. The new board brings a series of new features to Hemisphere GPS patented Crescent receiver technology including heave, pitch, and roll output, more accurate timing, lower phase noise, and an improved accelerometer. *www.hemispheregps.com*

Spirent introduces Wi-Fi Positioning Test Solution

Spirent GSS5700 Wi-Fi Positioning Access Point Simulator allows to test Wi-Fi positioning capabilities in suitably-enabled devices and chipsets. It allows real-world test scenarios, including simultaneous simulation of up to 48 Wi-Fi access points in the lab. This approach greatly reduces the need to conduct large-scale field trials while adding essential capabilities such as full user control and test repeatability. It can be combined with Spirent's GPS and multi-GNSS Simulation Systems to test hybrid Wi-Fi and GPS/GNSS technologies, with the unique ability to simulate motion of a mobile device through environments where both sets of signals are present. *www.spirent.com*

Autodesk Topobase 2011 Products

Autodesk released its Topobase 2011 products and its MapGuide Enterprise 2011 software, new tools that help customers manage infrastructure assets more effectively and plan for the future. With these products, infrastructure professionals can get a broader understanding of the location and status of their assets and more easily share information over the web. *www.autodesk.com*

New 3D Machine Control Software

Carlson's 3D machine control software, Carlson Grade, has many new and enhanced tools, which can be used with a wide variety of heavy machines and is designed to be a flexible and open 3D machine control system. Compatible with most heavy equipment, it support includes dozers, drills, loaders, scrapers, excavators, bucket wheel excavators, compactors, shovels, graders, and foreman trucks. *www.carlsonmachinecontrol.com*

Smallest Dual Frequency GPS receiver

NovAtel OEMV® receiver OEMV-1DF™ is only 46mm x 71mm x 13mm in size, it is the industry's smallest dual frequency GPS receiver to provide centimetre level, high performance RTK positioning. Weighing only 21.5 grams and consuming less than 1.1 Watts, it is ideal for size constrained applications. *www.novatel.com*

u-blox releases automotive dead reckoning GPS solution

u-blox has released a new Automotive Dead Reckoning (ADR) solution. It blends input from GPS satellites with vehicle sensors to determine position even where GPS signals are blocked or weak. It is compatible with virtually any car model or drive train type. It also supports a growing number of safety, security and road-pricing applications. *www.u-blox.com*

Trimble news

Trimble has been selected by 3 Australian state government organizations to modernize their respective GNSS infrastructure networks. The departments are Department of Sustainability and Environment in Victoria, Land and Property Management Authority in New South Wales, Department of Environment and Resource Management in Queensland.

Trimble announced improvements to its FX 3D Laser Scanner for applications requiring high accuracy and high quality data in industrial plant applications. The improvements extend the range of the Trimble FX to capture high resolution position information up to 80 meters. *www.trimble.com*

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Bengaluru Space Expo
25 - 28 August
Bangaluru, India
www.bsxindia.com

September 2010

ITS/Naviforum Shanghai 2010
1-3 September
Shanghai, China
www.naviforum.org

ESA International Summer School on GNSS
1- 11 September
Denmark
www.munich-satellite-navigation-summerschool.org/

IPIN 2010
September 15-17, 2010
ETH Zurich, Campus Science City
(Hoenggerberg), Switzerland
www.geometh.ethz.ch/ipin/

ION GNSS 2010
21-24 September
Portland, Oregon, USA
www.ion.org

G-Spatial Expo
19 - 21 September
Yokohama, Japan
g-expo@jsurvey.jp
www.g-expo.jp/en/

GDI APAC
28 - 30 September
Kuala Lumpur, Malaysia
www.geospatialdefenceasia.com

International Astronautical Congress 2010
27 Sep - 01 Oct
Prague Czech Republic
iac2010@guarant.cz
www.iac2010.cz/en

Geospatial Intelligence Summit
28-30 September 2010
Vienna, Austria
www.jacobfleming.com

October 2010

INTERGEO
5 - 7 October
Cologne, Germany
www.intergeo.de

GSDI-12 World Conference
19-22 October
Singapore
www.gsdi.org

CANEUS - Shared Small Satellites CSSP Int. Workshop
20-22 October
Tuscany, Italy
www.caneus.org/sharedsmallsats

GEOINT 2010
25-28 Oct
Nashville, Tennessee, USA
http://geoint2010.com

International Symposium on GPS/GNSS
26 -28 October
Taipei, Taiwan
http://gnss2010.ncku.edu.tw

November 2010

Trimble Dimensions 2010
8 - 10 November
Las Vegas, USA
www.trimble-events.com

XXX INCA International Congress
10 -12 November
Dehradun, India
www.incaindia.org

European Lidar Mapping Forum
30 November – 1 December
The Hague, Netherlands
www.lidarmap.org/ELMF/

November 2011

Regional Geographic Conference - UGI 2011
14 -18 November 2011
Santiago, Chile
www.ugi2011.cl