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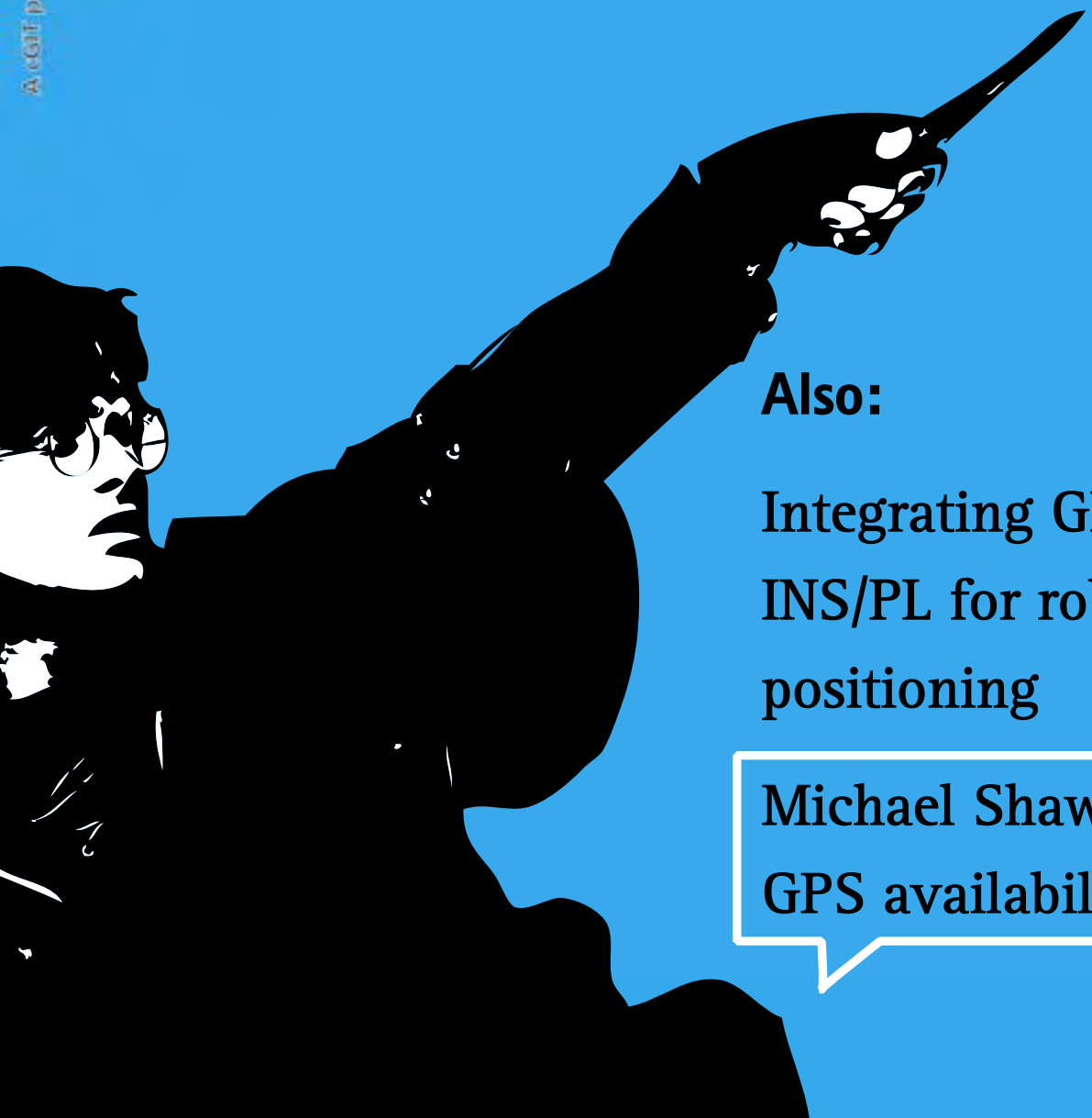
NSDI: Needs a magic wand



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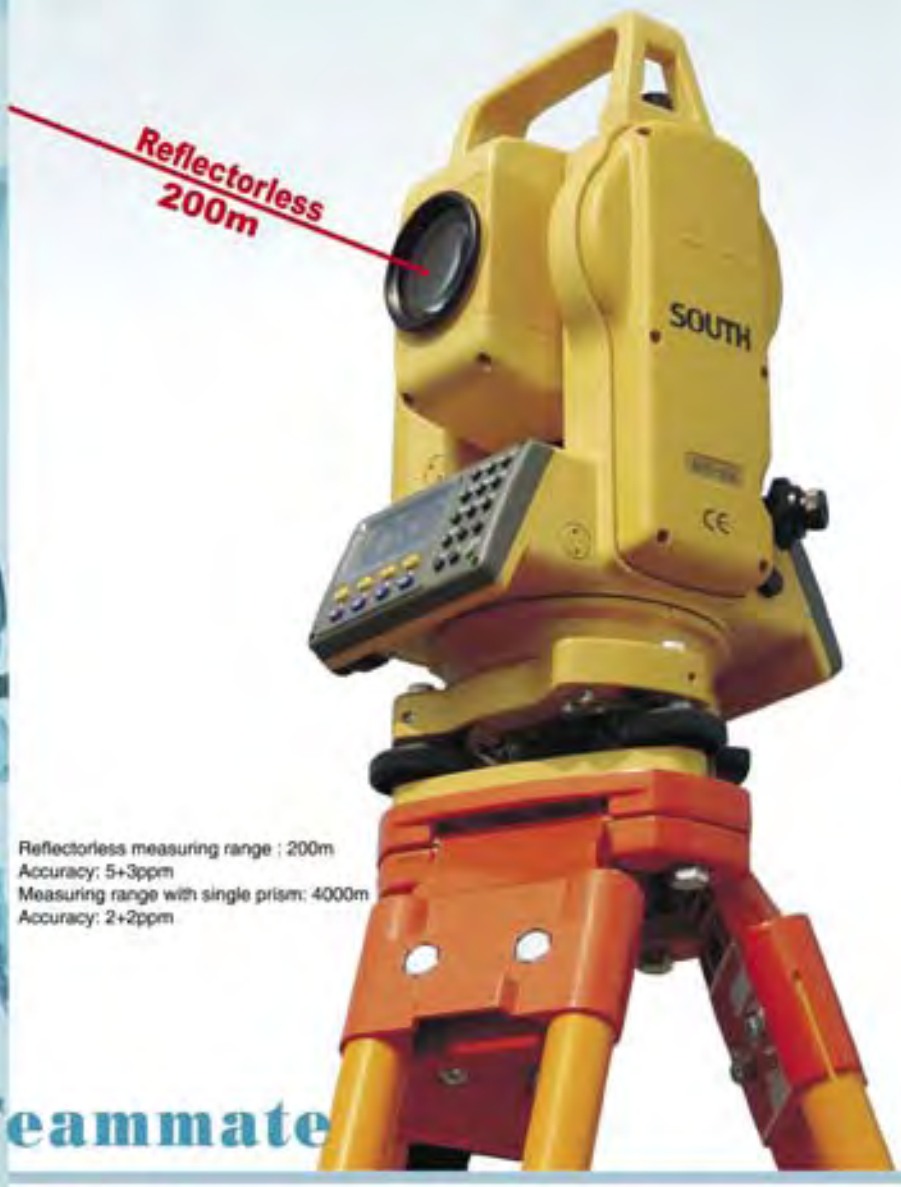

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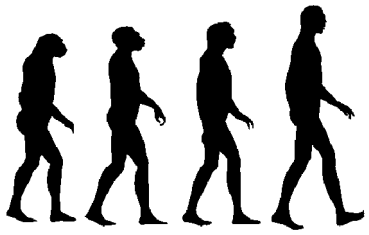


In this issue

Coordinates Volume 3, issue 7, July 2007

Articles

NSDI: Needs a magic wand 10 **Integrating GPS/INS/PL for Robust Positioning** Jinling Wang, Ravindra Babu, Di Li, Franics Chan, Jinho Choi 12 **Topographical mapping** P K Vachher, R Srivastava 20 **SEISIMPACT System** Ioannis D Doukas, Paraskevas Savvaidis 24 **GPS Enabled Mobiles Reclassified** 28

Columns

My coordinates editorial 4 **His coordinates** michael shaw 6 **News** industry 30 gis 32 galileo update 34 gps 34 remote sensing 35 lbs 36 **Mark your calendar** july to november 38 **Book Review** 38

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Breaking grounds

We published a circular by Central Board of Excise and Customs, Government of India that came out in April *(Coordinates, May 2007)*.

The circular classifies high technology featured mobile phone including GPS as a secondary feature as mobile phone.

That implies four per cent custom duty rather than 34 per cent as applicable to satellite phone.

A reason to cheer.

Especially for the cellular community. *(See page 28)*

However, we need to understand why this benefit cannot be extended to standalone GPS also.

Given the fact that the uses of GPS in infrastructure projects have become beneficial, and in many cases, essential too.

There is a case.

A strong case.

For a reduction in the duty from 34% to 4% across the board for GPS receivers.

Bal Krishna, Editor
bal@mycoordinates.org

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Everyone gets it or no-one does

— Michael Shaw, Director of the National Coordination Office for Space- Based Positioning, Navigation, and Timing (PNT), on the availability of GPS signals around the world

What's new in the U.S. space-based PNT policy released in 2004?

The previous policy published in 1996 was titled the "U.S. GPS Policy". If you look back in the 1990's, GPS was the only large constellation of navigation satellites providing full, worldwide service. Since then, the world's landscape has significantly changed in space-based PNT. Russia, Japan, Europe, India, China, and other nations have become involved in various efforts. In addition, many new augmentation systems came online within the United States and internationally.

We recognized GPS was not the only system, so the policy became the "U.S. Space-based PNT Policy." It addresses GPS, U.S. augmentations, and all similar systems. We also recognized the increasingly critical role of PNT to our nation, so a National Executive Committee was established at a very senior level to provide leadership on space-based PNT matters. One of the goals of the 2004 policy is to provide services that are at least competitive with other systems, while promoting interoperability and compatibility among them. Compatibility means systems do no harm to each other, and interoperability means the signals of all the systems can be used together. The intent of the new policy is to ensure we provide our services effectively and efficiently and to emphasize cooperation with other countries fielding space-based PNT systems.

Are there are more restrictions for other countries or is it becoming more open?

I don't think it is becoming more restrictive. From the U.S. perspective, the 2004 policy is how the U.S. intends to effectively and efficiently manage our own activities and how we represent the national policy externally. Again, national PNT policy reiterates many of the same policies we've had in effect since the mid 1990s. World-wide acceptance of GPS has been largely due to stable, predictable U.S. policy and very dependable performance by GPS. The U.S. will continue to modernize and improve GPS while recognizing that other countries will pursue their own interests. However, the U.S. policy emphasizes partnership and cooperation, not competition or confrontation, with other space-based PNT providers. The goal is compatibility and interoperability among space-based PNT services. We have made a considerable effort to communicate this policy to the international community and will continue to do so.

What do you think about the Galileo program?

Galileo is a planned system that has a number of unresolved issues, including adequate funding. The EU is trying to do many difficult things in order to field the system by mid-decade. The process is extremely complex and challenging. We are watching the program with great interest, as it has the potential to impact the global user community, commercial markets, and national security interests. The U.S. already has formal agreements in place regarding cooperation with the EU and the Galileo program. As Galileo continues to evolve, we will continue to watch to ensure the U.S. goals of compatibility, interoperability, open market access, etc., are still served.

What is your estimate about Galileo being operational?

I have often said that I believe Galileo will happen; the only issue is what it will be and when it will become operational. We've seen EU/EC officials quoted recently stating a best case scenario of somewhere in the 2012 to 2014 timeframe to start initial worldwide operations.

Why did the EU propose Galileo when the U.S. already had GPS in place?

Many countries are recognizing space-based PNT is a very important technology for both economic and security reasons, and they want to chart their own paths for using space-based PNT systems. I believe there is a view that if a nation wants to be a leader on the world stage that you must participate as a provider in space-based PNT services.

Looking to the future, the U.S. will continue to do provide civil access to GPS services, without direct user fees, as we watch other systems develop throughout the world. The U.S. will continue to do what we've done over the past 10 years, which is to maintain a very stable, predictable, cooperative national policy. We will continue to provide reliable, accurate, timely, and ever improving GPS and other space-based services.

Given the number of navigation systems, do think there is a need for a regulatory body?

I do not think that space-based PNT systems need to be "regulated" per se. To enhance compatibility and interoperability, there is value in promoting certain technical design standards, but this is already being accomplished through both multilateral and bilateral cooperation. They are already subject to international rules under the International Civil Aviation Organization, International

Telecommunication Union, World Trade Organization, and other such bodies. In addition, an International Committee of GNSS was recently established that is sponsored by the U.N. Office of Outer Space Affairs.

Cooperation within these existing structures may be sufficient to ensure the best results for worldwide space-based PNT users. It is too early to consider creating a separate regulatory body.

There is a general impression the U.S. can switch GPS on and off at will or by action by the Pentagon. Is that how the GPS system works?

Absolutely not. Unfortunately, that misperception has become a bit of a myth or media "legend." In reality, since GPS became fully operational in 1995, it has never been switched off. That includes during the September 11, 2001, terrorist crisis and during the ongoing conflicts in Iraq and Afghanistan.

From a practical perspective, if the U.S. were to switch GPS off, we would be switching it off for ourselves, too. That would do as much if not more harm to the U.S. GPS cannot be selectively turned off by region; either everybody gets it throughout the world or nobody does. As demonstrated over the past 14 years, the U.S. remains committed to providing uninterrupted, reliable service throughout the world for peaceful purposes.

But aren't other countries developing their own systems because of the perception the U.S. can switch off GPS?

That certainly could be part of their motivation. Regardless, the U.S. has committed to providing a worldwide utility, free of direct user fees. The U.S. has met that commitment for more than a decade, and will continue to meet it in the future. We are also committed to cooperation with other space-based PNT providers to ensure compatibility and interoperability so worldwide users have access to the best possible space-based positioning, navigation and timing services.

Is GPS III a natural evolution process or is it a reaction to Galileo?

GPS III is a natural evolution based on the U.S. commitment to provide the best possible worldwide PNT services.

The primary motivation for GPS III is to ensure uninterrupted PNT services remain available, while incorporating improved technology. Whether or not other systems existed, the U.S. would still continue to sustain and improve GPS, and there would be successive generations of improved GPS space vehicles and services. However, competitiveness and interoperability with other systems is certainly an important consideration for future generations of satellites, including GPS III.

It is important to note the U.S. is already launching new satellites with improved signals and services, prior to GPS III.

Michael Shaw is the Director of the National Coordination Office for Space-Based Positioning, Navigation, and Timing (PNT). He is responsible for carrying out the mission, objectives, and goals of the U.S. National Space-Based PNT Executive Committee in accordance with the U.S. Space-Based PNT policy.

In addition, he facilitates information sharing, coordination, and issue resolution regarding Department and Agency program plans, requirements, budgets, and policies for operation of U.S. space-based PNT systems and services. Lastly, he represents the Executive Committee on space-based PNT matters within the Government, the public sector, and with representatives of foreign governments and international organizations.

Previously, he was the Director of Navigation and Spectrum Policy in the Office of the Under Secretary of Transportation for Policy at the U.S. Department of Transportation. He oversaw implementation of the policy and planning of the Transportation Department regarding navigation systems and spectrum. This included participating in international negotiations involving GPS and its augmentations including the Wide Area Augmentation System (WAAS), Local Area Augmentation System (LAAS), and the Nationwide Differential GPS (NDGPS) System.

Shaw was a career navigator in the US Air Force where he was a Weapon Systems Officer in the F-4 Phantom aircraft. Later, he was also the Director of Operations, and later, the Commander of the 2d Satellite Operations Squadron, which is responsible for the command, and control of the GPS satellite constellation. He was also assigned to the Office of the Assistant Secretary of the Air Force for Space where he developed and coordinated Air Force space policy, planning, and strategy for various space systems to include GPS.

Following retirement from the Air Force, he served as the Project Lead for GPS Implementation in the Federal Aviation Administration (FAA) where he planned and directed satellite navigation policy within the FAA. Following that, Shaw was the Assistant for GPS, Positioning, and Navigation in the Office of the Assistant Secretary of Defense for Command, Control, Communication, and Intelligence (C3I) where he developed and coordinated policy, planning, and strategy for GPS in the Department of Defense.

Three GPS IIR-M satellites are on orbit, featuring a second civil signal for improved user performance. The GPS IIF series of satellites will begin launching in late 2008, and will have an additional third civil signal designed for safety-of-life navigation purposes.

The entire world has benefited by the free service that the U.S. has provided. When there is a doubt on the intention itself, do you think it shows lack of gratitude?

I believe the vast majority of users around the world trust the U.S. to continue providing a reliable, continuous GPS service. Otherwise, they would not be making such huge investments in critical infrastructures (telecommunications, transportation, power distribution, etc.) that depend on GPS. The voices of fear, uncertainty, and doubt that you hear from time to time come from very small factions to promote their own agendas.

The U.S. has made, and will continue to make, GPS technology publicly available, and will continue to advocate cooperation, compatibility, and interoperability with systems operated by other space-based PNT providers. If you want a realistic gauge of international user sentiment, just look at the global sales figures for GPS equipment – over $25 billion dollars per year with projections of double-digit growth rates in the years to come.

The U.S. PNT policy is two years old. Have you done any assessments of its impact?

Policy assessment is one of the functions of the National Coordination Office. We have taken an in-depth look at the policy and concluded that we are making good progress in meeting the goals and objectives of the 2004 policy. The unified effort to provide a global gold standard for PNT services is being met. We have established meaningful cooperation with many nations to ensure compatibility and interoperability between their space-based PNT systems and GPS.

The U.S. government is taking steps to ensure we continue to provide uninterrupted, accurate, reliable and dependable space-based services while continuing to evolve and improve GPS performance in the future. In short, the U.S. National Policy is working.

What do you think about China recently shooting down a satellite?

There is a lot of concern around the world about that type of activity for a variety of reasons. The entire space community is very concerned, because there is a tremendous amount of debris in orbit. Debris is dangerous for all satellites, regardless of type or function.

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NSDI: Needs a magic wand

NSDI in India runs the risk of losing its relevance.

That's the reality and that's the challenge.

The NSDI VI meet in Goa *(see sidebar)* was not able to rejuvenate the movement which is slumped by the feel of fatigue and frustration.

It was a high moment in the movement of NSDI when last year on June 13, the Government of India came out with a resolution on the constitution of NSDI.

The resolution established National Spatial Data Committee (NSDC) as an apex national authority for formulating and implementing appropriate policies, strategies and programmes for the establishment, operation, management of the NSDI and utilization and any other activities related to spatial data in the country.

Unfortunately, that became an end rather than a step to move forward; Nothing has moved thereafter.

Even a single meeting of NSDC would have helped. Its absence in the Goa meet was both intriguing and disturbing.

NSDI being no one's priority has a future that is bleak.

After six years of efforts, let us get back to basics.

Who needs it? Who owns it? What drives it and what stops it?

A time for introspection on what went wrong.

Bal Krishna, Editor

Yes Minister

"By March-April 07, a website will be announced which will allow users to access all the 4,800 Survey of India maps, where at a click of mouse, geographical and physical data can be superimposed"

— Kapil Sibal, Minister for Science of Technology in the Times of India, Feb 19, '07

NSDI: Realities and Challenges

28-29 June 2007, Goa, India

The Chief Minister, Mr Digambar Kamat has felt the scope to set up state or regional chapters for the faster implementation of National Spatial Data Infrastructure (NSDI). The Goa government, he said, would love to offer the first hub for such a chapter for Western India.

Mr Kamat was speaking after the inauguration of the two day National Spatial Data Infrastructure (NSDI) workshop "NSDI: Realties and Challenges" at Majorda, Goa. Mr Kamat also mentioned that with the notification of the Government of India on NSDI in June last year, it is possible to realize the dream of integrating all spatial datasets at its command into a user-friendly form for the economic development of the country.

However, we must agree that we have a long way to go. The evolution of data conforming to uniform standards is a crucial requirement.

Brig, Dr R Shiv Kumar, Head, NSDI, giving an overview of NSDI said, India has over the past produced abundance of qualitative map information through systematic topographic surveys, geological surveys, soil surveys, cadastral surveys, various natural resources inventory programmes and remote sensing images.

With the availability of precision, high-resolution satellite images, data enabling the organization of GIS, combined with theGPS, the accuracy and information content of these spatial datasets of maps is extremely high, he said.

In this welcome address Director General of Forest Survey of India, Dr Devendra Pandey said that, our technology is our biggest strength and specially our remote sensing capabilities are one of the best in the world.

The workshop was organized by the Forest Survey of India. It was attended by more than 70 delegates from different organizations from government, private and academia.

Goa Communiqué

The following recommendations have been made by the delegates during the NSDI-VI workshop held at Majorda Beach Resorts, Goa during 28-29 June, 2007:

1) Noting the excellent steps that have happened for approval of NSDI and the technical actions that have been initiated by many agencies, NSDI-VI expresses deep concern over the delays in operationalising the NSDI – even as more that an year has passed since the Notification.
2) Noting the Government resolution constituting NSDC has been issued in June 2006, the apex NSDC constituted under the resolution should be convened, in the next 1-2 months, and must initiate an Action Plan.
3) As identified in the Government Resolution on NSDI, the anchor-role of the CEO is seen as crucial for furthering the objectives and activities of NSDI. The delegates strongly urge the NSDC to immediately appoint and position a CEO and charge him with the Action Plan.
4) The operationalisation of the NSDI Portal and initiating the Metadata Services (and later Data Services and Applications Services) is yet another important step in bringing visibility for NSDI. The delegates note that all elements (technical and agency-level efforts) for the NSDI Portal are ready and available and the next steps of operationalising the NSDI Portal be accomplished by December, 2007.
5) Excellent work on NSDI Metadata, Exchange, Content Standardisation has been done – but it is time to re-visit and update these and confirm them once again for the future of NSDI. This activity may be undertaken by setting up expert sub-committees of NSDI by NSDC/EC.
6) There is an urgent need to address Standardisation in newer areas – NSDI Applications, Quality, NSDI database design issues IPR/Legal issues etc. This activity may also be undertaken by setting up expert sub-committees of NSDI by NSDC/EC.
7) Realizing the importance of Cadastral maps and the usage of NSDI at the grass-root level and also noting the urgent importance of Cadastral LIS in various states, NSDI may initiate a mission of National E-Cadastre – which will bring standardization and uniformity in bringing Cadastral GIS into NSDI. Efforts towards this must also involve defining E-Cadastre Standards and undertaking a Pilot for E-Cadastre leading into an operational programme.
8) The ultimate-success of NSDI will be when citizens and Society will benefit from the usage of NSDI Services – thus leading to the operational Enterprise-GIS solutions in the country. With this vision, NSDI may consider defining a plan for transitioning into a Service Oriented Enterprise GIS framework.
9) Noting the excellent progress made by SOI, FSI, GSI, NBSSLUP, NATMO, NRSA, CWC, Census and NIC at their-agency-server level efforts of NSDI, it is time now to integrate and plug them to the NSDI Portal and widen the scope of services available from NSDI.
10) The delegates discussed the provisions and implications of the National Map Policy – 2005 and noted that there is a need for addressing various aspects that impacts NSDI and GIS activities in the country in a major way. Thus, there is a need for dove-tailing the Map Policy and harmonizing it to further NSDI goals. In this connection, some of the important recommendations are as follows:
    a. With the availability of OSM, a major effort at transforming the legacy Everest/Polyconic GIS databases of NIC, FSI, GSI, NBSSLUP, NRSA and many other agencies has to be undertaken. Towards, this either the transformation parameters have to be shared by SOI or an institutional mechanism has to be in place for smooth transition of legacy-databases of various agencies to OSM framework
    b. Clarity is needed in the various terminologies of the Map Policy – as there were conflicting understandings of some of the terms. For example, there is a need for clear-cut DOs and DONTs for mapping activities in the country by agencies/users; terminology definition in the Policy has to be clear as there is conflict in understanding by various agencies – like, value-addition to OSM means what (the agency thematic mapping which just uses OSM as base reference must not be governed by the New Map Policy), Licensing terms, Sharing of data, Reuse of data etc; Media/Internet Licensing periods of OSM of 12 months is too short – rather it should be perpetual license; Placing OSM and thematic maps prepared by various agencies on the net must be allowed as OSMs have been de-sensitized already.
    c. There is an urgent need to integrate and modify the existing policies for ground survey data, aerial surveys data, satellite data, topographic/thematic/census/cadastral maps and GIS database into a comprehensive and holistic National Spatial Information Policy which will provide an over-arching framework for generation, archiving, utilization and dissemination of all forms of spatial data in the country;
11) Recognize that the datasets generated in the private sector have got potential for many applications and thus be made part of NSDI metadata. The private industry should quickly come forward to populate the metadata as per the standard of NSDI which will reduce duplication of efforts;
12) NSDI, with the support of DST, should continue the actions for a standardized capacity building endeavor so that the required number of professionals are available for furthering the NSDI goals;
13) The NSDI Secretariat is charged to initiate actions on the above and coordinate the progress, review and completion of the actions;

This Goa Communiqué for NSDI is adopted by 67 delegates from 12 departments/agencies at the 6th NSDI Workshop at Goa on 29th day of June 2007.

Integrating GPS/INS/PL for Robust Positioning

The challenging issues and progresses

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INERTIAL Navigation Systems (INS) are based on accelerometers and gyroscopes for position and attitude determination. Thus, INS is self-contained and autonomous. This makes INS an optimal option to be integrated with GPS, as both systems can complement each other to enhance positioning performance (Greenspan, 1996). On the one hand, the advantages of INS include high positioning (and attitude) update rates, and high short-term accuracy, both helpful in bridging the signal gaps between the GPS signal sampling epochs and the gaps due to signal outages. On the other hand, however, a major drawback of INS when operated as a stand-alone system is the time-dependent growth of systematic errors, which can be calibrated by GPS ranging measurements with consistent accuracy.

Over the past three decades, the following three modes for GPS/INS integration have been identified (Alban et al., 2003):

- Loose integrations
- Tight integrations
- Ultra-Tight integrations

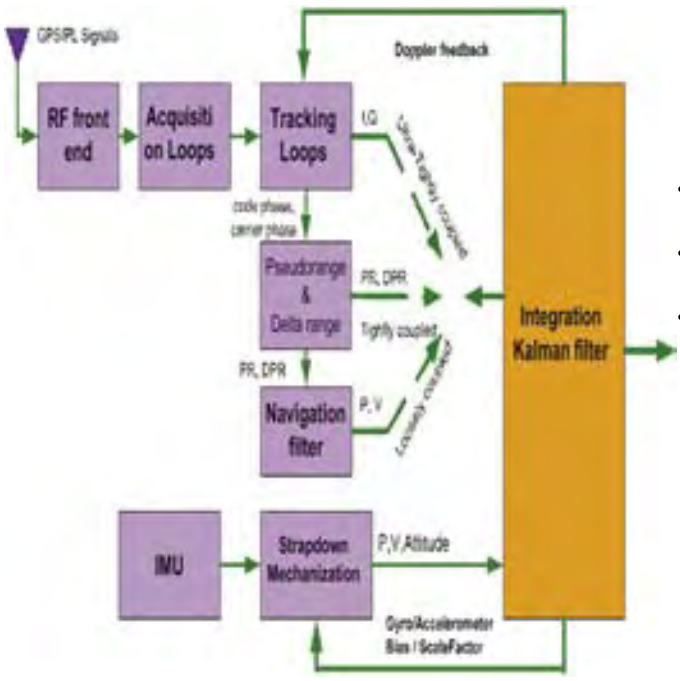

Figure1. GPS/INS/PL Integration Modes

In the loose integration mode, both GPS and INS are treated as independent navigation sensors and thus, a decentralized filtering strategy is used (Cunningham & Lewantowicz, 1988). GPS raw measurements are pre-analysed via a local (GPS) Kalman filter to produce the so-called GPS position and/or velocity information, which are then used to update the master (INS) filter for calibrating the INS errors and producing position, velocity and attitude information to users. However, one of the major drawbacks of the this early integration mode is that, when number of the tracked GPS satellites drops to fewer than four, GPS aiding of the INS is essentially disabled.

More recently, the tight integration mode has been the major research focus (e.g., Farrel and Barth, 1999; Grejner-Brezinska et al., 1998; Wang et al., 2000). In this mode, a centralized filtering strategy is utilized to process raw GPS and INS measurements. The raw GPS measurements are directly used as the update measurements in the single filter for the INS instrument calibration and navigation. This integration mode is much better than the loose integration mode.

Both the system level (loosely-coupled) and sensor level (tightly-coupled) architectures have been developed to demonstrate the robustness of the integrated system (Farrell & Barth, 1998; Greenspan, 1996). These integrated systems provided several advantages over the individual systems (e.g., Farrell & Barth, 1998). However, two primary drawbacks still remained: a) the integrated system is still vulnerable to problems caused by platform dynamics; and b) the receiver measurements that are used in the integration filter are correlated. In the former case, when the receiver dynamics exceed a certain threshold, the receiver loses lock on

the GPS signals. A sustained signal loss that exceeds the INS bridging level will result in the INS functioning in the 'free-inertial' mode, where error growth with time seriously degrades system performance. In the latter case, the state vector of the integrated Kalman filter (KF) can be augmented to account for the correlations, but this increases the overall computational complexity. In addition, these conventional tight integration modes are far from optimal in terms of weak signal tracking and interference suppression, which are critical in robust positioning. The ultra-tight integration of GPS/INS has attracted more and more attention over the past few years, because this integration mode can fully exploit the potential capabilities of each system and combine them in an optimal way, more effectively addressing challenging issues of positioning availability and reliability (e.g., Greenspan, 1996; Sennott & Senffner, 1997). Compared with both loose and tight integration modes, one of the major advantages of the ultra-tight integration is more robust satellite tracking, offering a more resistance to radio interferences and multipath noise.

Although GPS/INS integration can perform well even when few than four GPS satellites are being tracked, the low quality of the measurements and the undesirable geometry may significantly degrade the system performance. This issue can be effectively addressed with the inclusion of ground-based GPS-like transmitters – pseudo-satellites or pseudolites, which can be easily installed wherever they are needed. They therefore offer great flexibility in the augmentation of GPS/INS applications. In the early 1990s, researchers at Stanford University developed a low cost GPS L1 C/A code pseudolite. Due to the potential of the pseudolite applications in ubiquitous positioning, both theoretical and experimental research has been intensified over the past decade (Wang, 2002).

A new integration concept to include pseudolites into the tightly integrated GPS/INS system has been proposed and tested (Wang et al., 2001). Experimental studies on this concept have demonstrated potential benefits of the tight integration of GPS/INS/Pseudolites in terms of accuracy and reliability (Dorota et al., 2002; Lee et al. 2002). The integration concept of GPS/INS/Pseduolites has been further developed into the potentially highest level – ultra-tight integration, with the aid of smart antennas enhancing the weak signal tracking and inference resistance (Babu and Wang, 2004; Li and Wang, 2005; Chan et al., 2005).

This paper presents an overview of the ultra-tight integration, the features and performance of a variety of ultra-tight integration scenarios. Various challenging issues of the ultra-tight integration are discussed.

Development of ultra-tight Integration of GPS/INS/PL

Although the concept of ultra-tight integration and its advantages were published as early as in 1975 (Cox, 1982), nevertheless the system did not become popular due to the complexities involved in designing and implementing such a system 1980s.

The early 21st century has witnessed an increased interest and research activities in the area of the ultra-tightly integrated systems to address the aforementioned problems. The principal advantage of this integrated system is that a Doppler frequency derived from the INS is integrated with the tracking loops to improve the dynamic tracking capability of the receiver. Normally, the tracking loops can either be configured to increase measurement accuracy (with reduction in thermal noise) or to improve signal tracking performance under higher dynamics (Kaplan, 1996). However, in a ultra-tight integrated system, as the dynamics on the GPS signals are substantially mitigated by the integration of INS derived Doppler the tracking loop bandwidth can be optimised for accuracy and dynamics simultaneously (Babu & Wang, 2005; Jwo, 2001). The performance of both the code and carrier tracking loops has shown a significant improvement in this architecture (Babu & Wang, 2005; Babu & Wang, 2005; Babu & Wang, 2005; Li & Wang, 2006). As the tracking bandwidth of the carrier tracking loop can be reduced to about 3 Hz or so depending on the oscillator accuracy, an increase in the post-correlated signal strength of about 13 dB is observed (Alban & Akos, 2003). This increase in the signal strength can be effectively used in indoors, urban and foliage environments.

The integration modes are shown in Figure 1. The main advantage of ultra-tight integration is the carrier tracking bandwidth reduction which gives a plethora of advantages to the system. An accurate estimation of INS-derived Doppler is therefore important to reduce the bandwidth. Better stochastic models were used for modeling the inertial sensor errors to estimate the Doppler accurately (Li et al., 2005; Babu & Wang, 2004). Furthermore, the system performance has also been improved using antenna techniques (Malmström, 2003; Brown & Gerein, 2001). Compared with the conventional receivers (see Figure 2), the ultra-tight system has many advantages such applications as: a) acquiring and tracking weak signals (Soloviev et al., 2004); b) mitigation of jamming signals (Gustafson & Dowdle, 2003); c) combating interference signals Groves & Long, 2005).

Recent simulation studies on the ultra-tight integration mode have shown very promising results in improving signal tracking performance (e.g., Beser et al. 2002; Poh et al. 2002). Alban et al (2003) have recently reported that the benefits of ultra-tight integration can be achieved even with low cost inertial sensors. However, a great deal of research effort is needed to develop an operating system based on the ultra-tight integration mode.

Challenging Issues

The tracking loops in a GPS receiver should track both the pseudo-random noise code and the carrier frequency in order to extract the 50Hz navigation message data used for the position computation. In general, the tracking

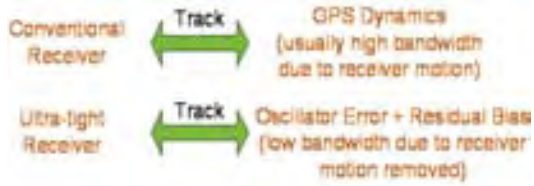

Figure 2. Comparison between conventional and ultra-tight receivers

loops, including a Costas Phase Locked Loop (CPLL) and a Delay Locked Loop (DLL), perform well under normal signal strength and moderate dynamic conditions. However, if the signal strength is weak or distorted due to obstructions, and if the dynamics exceed a certain threshold, the performance of the tracking loops degrades considerably. The tracking bandwidth and the dynamic stress are the two conflicting parameters that need to be optimised in a receiver operating in such 'stressed' scenarios (Ward, 1998). A conventional receiver is optimised either to receive weak signals or to handle high dynamics, but can not address both issues at the same time. However, simultaneous optimisation is possible by adopting augmentation techniques. INS which is collocated with the GPS antenna also measures the vehicle dynamics on which it is mounted. If this navigation information from INS can be converted into the Doppler domain (Doppler and Doppler rate), then it can be integrated with the GPS tracking loops to mitigate the Doppler on the GPS signal. With the Doppler due to the vehicle dynamics on GPS signal mitigated, the Costas tracking loop bandwidth can be substantially reduced, resulting in a significant threshold improvement (Sennott & Senffner, 1997; Ward, 1998). This approach not only removes the platform dynamics from the GPS signal, but also reduces at the same time the tracking loop bandwidth, thereby improving the overall system performance, see the ultra-tight integration system structure shown in Figure 3.

Modelling INS and GPS/PL measurements

The raw inertial sensor outputs are not error-free but are contaminated with two types of error sources: deterministic and stochastic. The navigation parameters, position, velocity and attitude are usually modelled as deterministic errors, whereas the residual biases from the sensors are modelled as stochastic errors. The strapdown INS deterministic models are well-defined and obtained by linearising the mechanisation equations and considering only the first-order terms. The higher order terms are generally ignored. The commonly used models to estimate the stochastic errors are random walk, 1st and 2nd order Gauss-Markov (GM) models. However, the most popular one is the 1st order Gauss-Markov model. Since the deterministic models are well defined, the Kalman filter estimates the inertial errors accurately and removes them from the raw measurements. Nevertheless, the stochastic errors can be estimated only approximately as they are based on the probability theory. In ultra-tight integration, a Doppler signal derived from the inertial estimates is integrated with the tracking loops to remove the dynamics from the GPS signal. As the total Doppler on the GPS signal is removed the carrier tracking loop bandwidth can be reduced to the order of 1 to 5 Hz depending on the oscillator accuracy. However, if the Doppler estimate is not accurate, it results in an increase in the loop bandwidth. Unfortunately, the stochastic errors cannot be modelled very accurately; therefore, the INS-derived Doppler still has residual biases. In order to improve the accuracy, the Autoregressive (AR) models based on discrete time-series techniques can be used to model the stochastic errors of the inertial sensors.

Conversion of sampling rates is often necessary in GPS applications as various subsystems or augmented systems of the receiver operate at different sampling frequencies. For instance, in a conventional GPS receiver, the base band processing takes place at about 1000Hz, whereas the navigation algorithms are executed at about 10Hz. Similarly, in an integrated GPS/INS system, the GPS receiver behaves as a low rate sensor providing output at about 10Hz, whereas the INS is treated as a high data rate sensor providing measurements at about 100Hz. In the case of ultra-tight integration, the principle advantage stems from the fact that a Doppler signal derived from INS is fed back to the tracking loops for dynamics reception. Since the integration Kalman filter runs at 10Hz the Doppler measurements derived from the filter are also obtained at the same 10Hz rate. However, for integrating with the tracking loops, a sampling rate adjustment should be done. Two approaches to match these rates are: first, the integration Kalman filter can run at higher data rates, i.e. 1000Hz, so that the sampling rate of the INS derived Doppler matches with the tracking loop rate; second, the Doppler measurements can be interpolated to the required rate (Beser et al., 2000; Gardner, 1993). Obviously, the latter approach is preferable due to its lower computational burden.

To achieve the sampling rate requirements at various stages of the integration system, sampling rate converters are used. A discrete time based multi-rate system which employs the two basic sampling rate devices, up-sampler and down-sampler is used. As the up-sampling and down-sampling functions distort the original signal in the process of sampling frequency conversion, digital lowpass filters

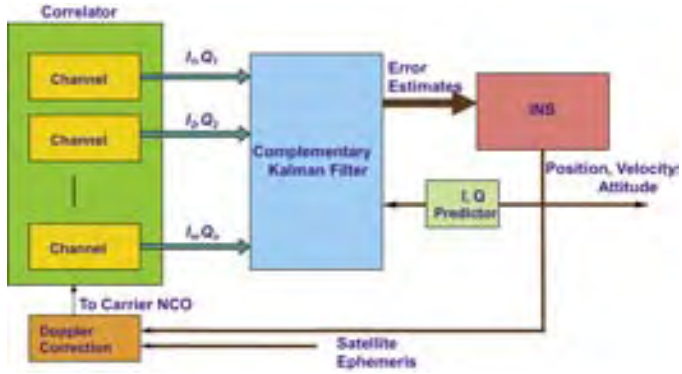

Figure 3. Ultra-Tight Integration Architecture (Babu and Wang, 2005)

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are used invariably when using these sampling rate converters. For linear applications, digital filters predominantly use finite-impulse response filters (FIR) which produce a linear phase output, i.e. the original signal characteristics are maintained. The realisation of the transfer function of the FIR filter, in general, is computationally intensive. Efficient realisation of the FIR filter is possible by adopting Polyphase Decomposition and Cascaded-Integrator Comb (CIC) techniques (Hentschel & Fettweis, 1990).

Integration of pseudolite with GPS/INS

The major limitation of the GPS navigation is the poor satellite geometry which results in a high PDOP (Position Dilution of Precision) even with a full view of the constellation. Especially, the vertical accuracy of the receiver is about 2 to 3 times worse than the horizontal components due to a poor VDOP (Vertical Dilution of Precision). For applications such as precision approach this is a serious constraint. In addition, the weak signal strengths in urban canyons, foliages, signal obstruction / distortion due to high rise buildings generally cause problems in GPS based navigation. These problems can be addressed by combining pseudolites with GPS. The pseudolites can be flexibly located at the area of operation, for instance, they can be placed near the airports to meet the stringent requirements of aircraft precision approach and landing. The transmitter power and signal structures can be optimised for navigation in difficult environments. In general, the overall receiver performance can be improved substantially by the integration of pseudolites.

The isolation between GPS and pseudolite signals is achieved by using different PRN codes. While the satellite constellation is allocated with PRN codes 1 to 32, the ground-based pseudolites are allocated PRN codes 33 to 36. These unique codes belonging to the same Gold code family permit the GPS receiver to be easily customised to track the pseudolite signals also. However, there are two important issues that affect the receiver performance when using pseudolite signals. The first issue is, due to the proximity of the pseudolite transmitter the pseudolite-to-receiver geometry changes are high compared to satellites-to-receiver geometry, resulting in higher Doppler changes. For tracking these higher Doppler signals, tracking loop optimisation or external signal augmentation is required. The second issue is, the larger power fluctuations in the received signal require the receiver to have higher dynamic range capability in the order of 60dB or more, i.e. a receiver that is 10m from the pseudolite will have about 70dB stronger signal than a receiver that is 10km away from the pseudolite.

The advantage of integrating pseudolite signals with GPS signals is to improve the overall geometry, defined by GDOP (Geometric Dilution of Precision) which is provided by the trace of the position covariance matrix which depends on the measurement geometry. This improves the integrated system accuracy in addition to enhancing the availability and the reliability of tracking. However, this integration approach can be limited only to outdoor applications as the GPS signals may not be tracked indoors.

Therefore, in a 'pseudolite-only' constellation, by increasing the number of pseudolite transmitters and placing them appropriately, the operating environment can be optimised for both geometry and availability of signals. The problem of tracking higher Doppler changes in indoor environment by combining the pseudolite signals with INS data in ultra-tight configuration has been an area of interest. The higher Doppler changes require higher tracking loop bandwidths and higher order loop filters that may cause potential stability problems. By integrating the INS-derived Doppler with the tracking loops, the dynamics on the pseudolite signals can be effectively reduced. This integration strategy also results in lower tracking loop bandwidths which provide better immunity to multipath signals. In this integration approach, the pseudolite signals I and Q were used for integration with the INS navigation information. The simulation studies have shown a significant improvement in the performance of the integrated system.

Multiple access interference and near-far effects

The key to the reliability of any radio navigation and positioning system, such as GPS or pseudolite, is the high performance signal acquisition and tracking within the receivers. However, there are still some unrealistic assumptions in developing the existing signal acquisition and tracking strategies.

Current GPS receiver designs do not consider the Multiple Access Interference (MAI) and Near-Far effects, limiting receiver's capability to acquiring and tracking weak ranging signals (Fu & Wang, 2003). The mass market demands the production of low cost receivers with the best possible performance, i.e. they are able to operate in the environment where the most of the consumers live, travel and work, such as in a moving car, big urban and suburban or even indoor areas. It is necessary to develop new receiver architectures, which have the possibilities of MAI mitigation and Near-Far resistance.

Generally, the performance of GPS/ pseudolites positioning systems is degraded by 1) multipath interference and 2) jamming signals. In addition, the GPS signal is weak. These difficulties should be overcome for the reliability of GPS positioning. Smart antennas can provide means to mitigate interfering signals as well as to improve the signal strength so that the reliability of GPS positioning operation can be significantly improved.

Recent developments of inertial sensors, such as, Micro-Electro-Mechanical System (MEMS) inertial sensors and magnetic inertial-type sensors, have significantly improved the systems performance, but at the same time, the cost has been reduced drastically. The use of inertial sensors in aiding GPS/pseudolite signal tracking will be coming more and more important for robust positioning.

Integration filter

In ultra-tight integration, the design of the integrated Kalman filter is critical. Due to the complex measurement model, the computational requirements for a centralised filter approach are high. Therefore, decentralised techniques based on federated Kalman filter approach were used for efficient real-time implementation (Beser et al., 2002; Sennott, 1992; Li & Wang, 2005). The design and performance of the Kalman filter was explained in (Babu & Wang, 2005; Kim et al., 2006)

Depending on the observations utilised by the Kalman filter, the linear or nonlinear Kalman filter based ultra-tight configurations are currently under investigation. Compared with the pseudorange and pseudorange-rate data used as observations in the linear Kalman filter, the in-phase (I) and quadrature (Q) data from the GPS correlators are highly nonlinear, therefore it is necessary to utilise nonlinear Kalman filter techniques. In order to improve system performance there are many issues which should be taken into account in the design of the Kalman filter, including the methods to mitigate the correlations in the tracking loops (see Figure 4) and the stochastic modelling approaches used to estimate realistic stochastic models for both measurement and dynamic noises.

In addition, the system integrity should be addressed in the filter design to deal with potentially multiple faults in raw measurements and dynamic assumptions. Traditional RAIM concept can be extended for the ultra-tight integration scenarios.

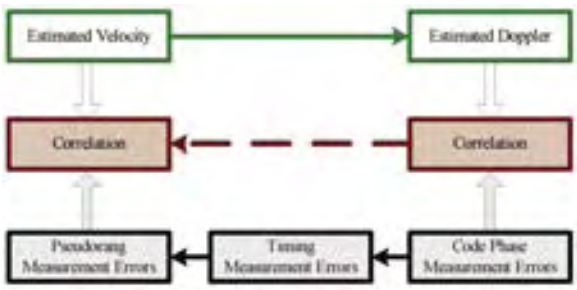

Figure 4. Relationships between Various Measurement errors (Li and Wang, 2005)

The Kalman filter structure adopted for the ultra-tight system is another challenging issue. Although the centralised Kalman filter is commonly employed, because of the large computational load of such a filter the federated Kalman filter-based ultra-tight structure has been developed to distribute the computing tasks between different Kalman filters, leading to reduced overall filter complexity and computational requirements.

Smart Antenna Array

Smart antenna systems are generally used for wireless communications to improve the performance (Liberti & Rappaport, 1995). A novel smart antenna design can suppress interfering signals and provide diversity gain in terrestrial communications (e.g., Choi, 2000). Such smart antenna concept will be further developed and applied in the proposed robust positioning system to improve the performance of GPS systems by properly combining the multipath signals and mitigate interfering signals. With the use of attitude information from inertial sensors, vector signal processing methods that are defined in the space-time domain will be developed to reduce the estimation error in acquisition and tracking for robust positioning, addressing the positioning availability and reliability issues.

By employing smart antennas, we can null and cancel the multipath interference signals and other intended or unintended interference signals. These operations are carried by the space-time signal processing. The basic concept of the space-time signal processing can be shown in Figure 4. The signals can be seen as vectors in a vector space. The antenna array can null the strong delayed signal in the space domain. Using the interference cancellation technique, the jamming signal can be cancelled out. This operation can improve the performance of positioning by mitigating the multipath signals and jamming signals.

The mitigation of interfering signals for GPS/pseudolite positioning will be quite similar to that for CDMA systems. The major difference, however, is the desired signal or parameter to be estimated. In GPS/pseudolite positioning, the desired signal is the line of sight (LoS) signal that can be weak or strong depending on the propagation environment. With appreciating this, it is required to identify the LoS signal from the received signal. To do this, the received signal vector through antenna arrays is analysed. This task can be carried out by building a simulator with antenna arrays. In addition, the development of antenna arrays for GPS/pseudolite needs to be carried out to collect GPS/pseudolite vector signals through antenna arrays and to design best antenna arrays. Initial results in this direction are encouraging (Chan et al., 2005).

Initial Experiments

A real-time experiment was conducted near the campus of University of New South Wales (UNSW) on the 20th and 21st December 2005 using a C-MIGITS II IMU and a Nordnav Software receiver. The IMU (position, velocity and attitude) and GPS data (I, Q) were recorded for about 15 minutes by driving the car in the suburbs of Kingsford near the UNSW. The trajectory obtained from the software receiver is shown in Figure 6. The raw inertial measurements sampled

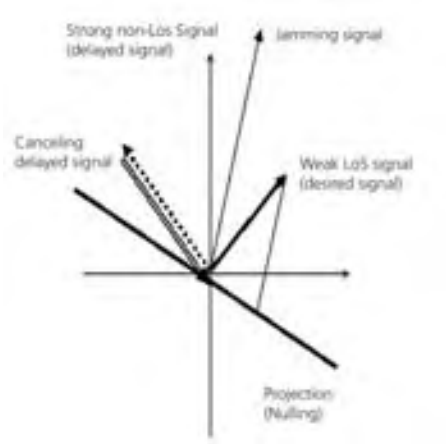

Figure 5. Signal processing concept to null and cancel interfering signals

Figure 6. Vehicle trajectory obtained from the NordnavTM software receiver

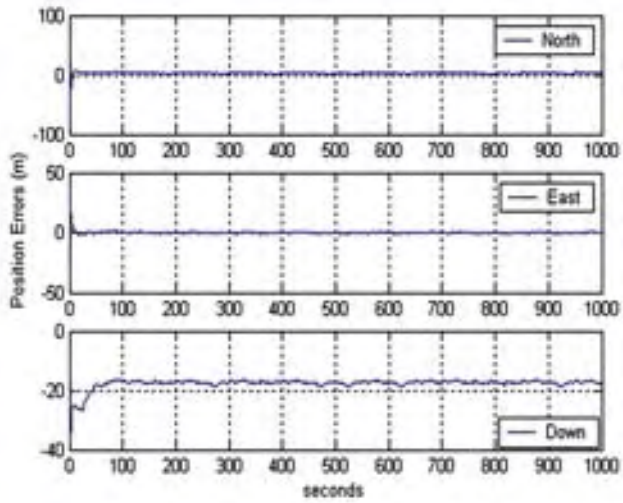

Figure 7. Position differences of ultra-tight GPS/INS estimates from the software receiver trajectory

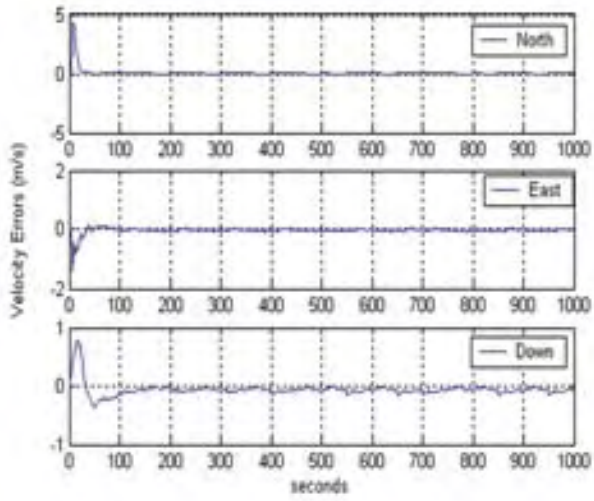

Figure 8. Velocity differences of ultra-tight GPS/INS estimates from the software receiver trajectory

at 100Hz were processed by the INS Software to provide delta velocity and delta angle. Similarly, the correlator measurements sampled at 10Hz were processed by NordnavTM Software to provide the I, Q, position and velocity measurements. It should be noted that the four satellites used for the experiments are: PRN 4, PRN 6, PRN 10, and PRN 12. Though some low elevation satellites were tracked, as the observations get contaminated with atmospheric effects and multipath, they were ignored from the analysis. A 17-state centralised Kalman filter is used to process these data.

The filter estimates were evaluated by comparing with an independent trajectory obtained from the software receiver. In addition, the standard deviations of the estimated navigation parameters were also analysed to check the consistency of the estimates. Some statistical assumptions in modelling the Q (process noise) and R (measurement noise) matrices of the filter are:

Correlator errors were white noise with standard deviations for I $\sigma I = 0.5$ and for Q $\sigma_Q = 0.1$, respectively;

INS noise for position was $\sigma_{pos} = 0.25m$ and for velocity $\sigma_{vel} = 0.05m/s$, respectively

Figures 7 & 8 illustrate the positioning and velocity performance of the ultra-tightly integrated system, obtained from a comparison between the integrated filter estimates and the software receiver navigation data. Note that the software receiver computes the navigation data based on the code-based pseudo-range measurements. The plot shows that the North errors are less than 5m, East errors less than 2m, and the vertical errors less than 20m. Occasional spikes of about 3 m in North error at epochs 550, 630, 840 and 950 can be observed due to the loss of GPS signals in one or more channels at those instances. Two important conclusions can be drawn from the results: firstly, the differences in the vertical component are relatively larger than the horizontal components. This can be attributed to the poor vertical geometry of the satellite constellation (HDOP: 3 .2, VDOP: 5.5). The mean and the standard deviations of the positioning differences are tabulated in Table 1. It should be noted that the vertical mean shows 17.65m in contrast to 3.13m and 0.54m for the horizontal components respectively. From the analyses of the results presented in Figures 7 & 8 as well as Tables 1 & 2, it can be summarised that the position and the velocity accuracies of the integrated system are stable and are within the accuracy bounds as can be expected by using a single frequency code-based receiver.

Concluding Remarks

During the past two decades, GPS has

Table 1. Mean and standard deviation of the position errors between the reference trajectory and the KF estimated trajectory

	Position Errors (Difference between GPS/INS and SW trajectory)	
	Mean (m)	Std. deviation (m)
Δ Northing	3.13	3.01
Δ Easting	-0.54	1.64
Δ Height	-17.65	1.79

Table 2. Mean and standard deviation of the velocity errors between the reference trajectory and the KF estimated trajectory

	Velocity Errors (Difference between GPS/INS and SW trajectory)	
	Mean (m)	Std. deviation (m)
Δ Northing	0.06	0.34
Δ Easting	-0.05	0.10
Δ Height	-0.05	0.11

revolutionised surveying, geodesy and other position-sensitive disciplines, such as transportation, personal location and telecommunications. The ever-increasing dependence on the GPS has triggered more and more concerns about the robustness of GPS. However, the recent studies conducted by some leading organizations, such as Volpe National Transportation Systems Centre in the USA, have revealed that GPS cannot perform reliably under weak signal and/or radio interference environments. This critical issue, which may be even a concern of safety-of-life in such positioning applications as aircraft automatic landing or rescue efforts in the high-rise buildings, can be addressed by the ultra-tight integration of GPS/INS/PL.

Fundamentally, radio based positioning systems and inertial sensors have complementary characteristics, offering an ideal integration scenario for a robust positioning and navigation system. In contrast to the existing ultra-tight 'twin' integration of GPS/INS, the inclusion of pseudolites into the system will significantly boost the positioning performance as pseudolites can transmit stronger signals than GPS from any desirable locations, ensuring an optimal geometry for positioning operations. In addition, where GPS signals are totally lost/jammed, pseudolites can even replace the GPS as a back-up means of positioning (Wang, 2002). The developments of pseudolites should also address optimal combinations of frequencies and signal structures for a wide range of application environments (Jovancevic, et al., 2007)

This paper has presented an overview of the GPS/INS/PL research and discussed such challenging issues as Modelling INS and GPS/PL measurements; Multiple Access Interference and Near-Far effects; Integration of Pseudolite with GPS/INS; Integration filter, Smart Antenna Array. Finally, the initial results from the real-time experiment demonstrate the robust performance of the ultra-tight integration.

Acknowledgement

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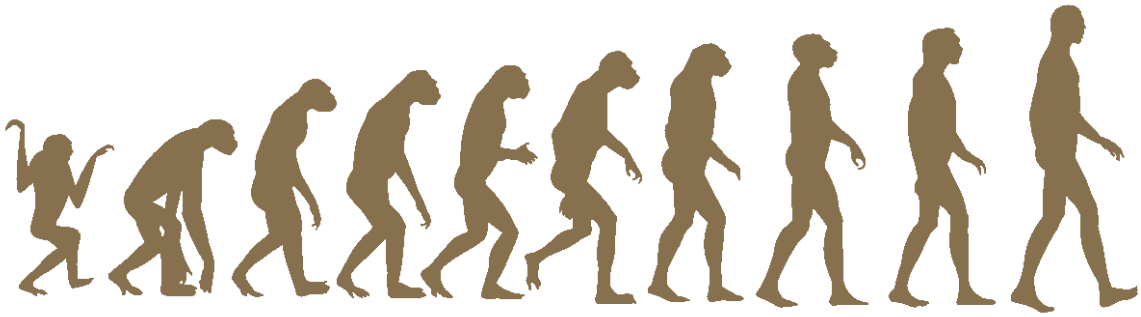
The paper with detail references can be viwed/downloaded at www.mycoordinates.org



Topographical mapping

A historical perspective

PK Vachher, R Srivastava
NGDC, Survey of India, DehraDun

SOME of the earliest known maps were made in Iraq which was drawn during 2400 BC for the purpose of land taxation. A Roman map dating 350 AD showed such topographical features as roads, cities, rivers and mountains. Although the basics of land surveying were known but the large scale maps before 16th century were limited to cities and other small areas. Up to the middle of 16th Century, there was little real knowledge of the geography of the most part of the world.

In 1539, a Dutch mathematician and geographer described the concept of triangulation, which became one of basic technique of field surveying and mapping and is still used today. One of the first large mapping project using triangulation was started in France in 1670 by Cassini. After a century of work by Cassini, his son, grandson and great grandson and their teams, France became the owner of first topographical map series for the entire country. It was published in 1793 as Carte de Cassini. The concept of contour line to show different elevations on the map was developed by a French engineer in 1791 and it became popular after 1850.

Background

A topographical map is two dimensional representations of three dimensional land surfaces through a combination of contour lines, symbols and texts. Topographical maps portray the shape and location of mountains, forests, rivers, lakes, cities, villages, roads, rails, bridges and most of other natural and manmade features existing on surface of earth. They also contain reference systems like graticule lines, grids, benchmarks, magnetic declination etc. Topographical maps are used by defence forces for planning operations as well as by administrators, civil engineers, natural resources managers, town planners, emergency service agencies, outdoor enthusiasts, historians, geographers etc.

Establishment of topographical mapping agencies

Real interest in topographical mapping was created when nationalism began to develop as a potent force in Europe and these countries began to undertake detailed topographical survey. At the same time European countries started colonizing the other parts of the world. They gave importance to topographical mapping, as it was required for accessing and controlling the new areas. National Mapping Agencies in some form or the other were established in most of the countries during 18th and 19th centuries. In India the Surveyor General of Bengal was appointed in 1767 and Surveyor General of India was appointed in 1815.

Methodology of surveying and mapping

Early methods

Mapping the untrodden country was a

difficult and hazardous task. Extreme challenges awaited the mapping pioneers. Travel was arduous and costly. Many locations could be reached by traveling for months after crossing large rivers, high mountains, forests full of wild animals and hostile tribes. Furthermore surveying and mapping instruments were crude by today's standards and difficult to carry. Origin of control was fixed by observing the stars. Initial base line was measured and the control was extended by triangulation. Most maps were made using a classic mapping technique called plane-tabling. The maps were reproduced by hand drawing or by copper engraved printing technique. Maps around 1:250,000 were generally prepared during this period.

Methods during last century

Some sorts of maps or charts were available to surveyors to plan their work. Most of the countries extended the triangulation series throughout the country to bring all maps on uniform reference system. Similarly leveling lines were started from coasts. Heights above mean sea level were given as benchmarks. Detailed survey was still carried out by plane tabling method. After 1930, overlapping aerial photographs revolutionized the mapping technique. Detailed survey was done in office by photogrammetric methods, which was subsequently verified on the ground. After that, map was cartographically fair drawn and printed on offset printing machines. Producing an accurate topographical map was still a long and complex process. It used to take about ten years from planning to finally printing the map. This process required a team of dedicated professionals and a series of closely coordinated steps. Maps from 1:24,000 to 1:100,000 scales were generally prepared during this period.

Modern methods after 1990

After 1990, digital mapping techniques revolutionized all stages of map production. Now the control points are provided by GPS/GNSS. Digital photogrammetry can automatically or semi automatically extracts contours and other details. Field verification can be done on palmtops/laptops by easily inserting or deleting details. Map finishing can be done semi automatically by using patterning software and colorful maps can be printed by CYMK techniques. Several complex processes required for printing a map by conventional techniques are no more required. Many countries have fully switched over to modern methods whereas some countries are struggling to produce desired results with the help of new technology.

Some interesting facts about topographical mapping

Underestimation of efforts needed to produce topographic maps

An interesting fact was noticed that almost all countries initially underestimated the time frame required to complete the topographic survey on the selected scale. For example India decided in 1905 to complete the topographic mapping at one inch equal to one-mile scale within 25 years with revision cycle of 25 years. But it took 75 years to complete the series with revision cycle of more than 25 years. Similarly topographic mapping projects were delayed in USA, France, Sweden, Australia, China, Brazil etc.

Restriction in access of topographical maps

Once the importance of topographical maps was realized for accessing and controlling the new areas, colonial powers restricted the access of such maps to prevent it falling in the hands of hostile powers. During the World War I and World War II, the restriction policies were given more teeth.

After Second World War topographical maps and aerial photography were extensively used for developmental activities and rebuilding the nations. Considering the importance of these maps as well as aerial photography for such activities, countries like USA, UK, Germany, France, Switzerland etc. removed almost all restrictions on their use. However, the civilian editions of these maps do not depict sensitive details like nuclear plants, defence installations etc.

Availability of topographical information from various sources

Now with the availability of high-resolution stereo satellite imageries, information about topography of all parts of world is known and openly available unlike in previous centuries. In fact Google-earth depicts almost all major towns with high-resolution satellite imagery. Anyone having the internet connection can take a virtual world tour of major cities and tourist places in the world. He may also see beautifully laid out aerodromes, nuclear plants, magnificent buildings, his own house and surrounding area etc. Many people are arguing if geographical information cannot be denied to adversaries; why not use it freely for own development. Therefore many countries are reviewing the pros and cons of map restriction policies.

Spatial Data Infrastructure

Many government and private organizations had created geo-spatial data for their own use during the last few decades for economic activities. It resulted in geo-spatial data explosion and often duplication of efforts. To avoid duplication of efforts and take full advantage of already created data, many countries have created an organization known as National Spatial Data Infrastructure (NSDI). Well defined standards are being developed for Spatial Data infrastructure (SDI) at national and international level to give information about the quality & availability of various type of geo-spatial data as well as to facilitate data exchange. However, it has been noticed that unless participating agencies cooperate whole heartedly, NSDI can not achieve the desired results.

Development of topographical maps in some countries

USA, Australia and China are chosen for case studies, being large countries.

USA

In 1807 President Jefferson established the 'Survey of Coast' that was renamed in 1836 as 'US Coast Survey' and 1878 'US Coast and Geodetic Survey'. This organization surveyed the area near the coast line till 1878. In the meantime the mapping of interior of county was done by several organizations including 'Army Corps of Topographical Engineers'. First maps were generally drawn by hands. Different groups were working in uncoordinated way. Therefore US Geological Survey was established in 1879. USGS started with topographic survey on various scales from 1:24,000 to 1:250,000. But the object of complete coverage could not be achieved by target year of 1925.

Thereafter the National Topographical Program was introduced in 1939. This legislation laid down the specifications for the National Topographical Map Series and appropriate standards of map accuracy. Based on this programme 1:24,000 scale (except deserts), 1:62,500 scale (in Alaska 1:63,360) and 1:250,000 scale surveys were adopted. USGS began using aerial photographs to produce and update maps since 1930s.

By 1947 maps at the scale of 1:24,000/1:62,500 covered only 25% of USA but by 1968 this had been increased to 78%. In 1976, national coverage at 1:24,000 was 68% complete and about 80% of the Alaska (at 1:63,360) had been covered. By that time many countries including India had almost complete coverage on 1:50,000 scale.

In order to speed up the revision of existing map sheets, an interim revision was introduced in 1967. Extensive and important topographical changes were overprinted in purple on exiting maps by using aerial photography but without field check.. In 1975, it was decided that for all areas not yet covered by traditional 1:24,000 scale sheets, orthophotoquads (rectified photographs with important details, names grid/graticule and marginal items etc) should be produced especially for deserts and less developed areas.

As it became evident that complete coverage by traditional maps at 1:24,000 scale could not be achieved before the end of century, manuscript maps without cartographic fair drawing have been printed since 1982.

Based on the Metric Conversion Act of 1975 a modification of official topographic maps of the USA was made to confirm to the metric system. In the 1980s, the use of computer to scan, redraw and publish the maps significantly reduced the time required to update maps in areas of rapid growth. A new series on 1:100,000 scale was published which was compiled from 1:24,000 scale maps. Some states adopted 1:25,000 scale after adoption of metric system.

Now the complete country except Alaska is covered by more than 55,000 sheets produced on 1:24,000/1:25,000 scale and Alaska is covered by 2,700 sheets on 1:50,000 scale. In addition complete topographic coverage of USA is also available at 1:100,000 scale and 1:250,000 scale. Most of the data is now available in digital form. Maps or data can be obtained by anyone without any restriction. USGS provides topographical maps, orthophoto maps and aerial photographs in the entire USA online for nominal charges. This data is also available from various websites e.g. topozone.

There is demand for complete and up to date topographical information. For a country of the size of USA , it is huge task even with the latest technology. Therefore to meet this requirement, USGS has started 'The National Maps Corps Volunteer Programme'. Any citizen having a GPS receiver can become the volunteer for a selected part of the country. He will provide GPS data and information about new details. After validating the information, the USGS staff will update the topographical database. Now USGS is expecting that the changes in topographical data will be captured and integrated with the existing data in a process of continuous update, rather than through cyclical revision of 10 to 20 years. They expect that currentness of the data will be measured in months and not in years and decades.

China

China also underestimated the efforts needed to produce the topographical maps and in 1903 they originally targeted to produce a map series at 1:25,000 scale. But this proved impossible due to the insufficiently advanced state of available technology and the enormous geographical extent of the country. In 1914 it was decided to generate mapping at 1:50,000 and 1:100,000 scale as an alternative. Preparation of these series was interrupted due to outbreak of World War I. Moreover sheets produced prior to that, were strongly criticized because of their general inaccuracy. In 1928 a revised programme was introduced by the newly created Central Bureau of Land Survey (CBLS). Triangulations commenced in 1930 and from 1932 photogrammetric techniques were used for topographical survey. Tremendous efforts were made but the progress suffered because of civil conflicts and the war between China and Japan. Till then, the scales employed were 1:25,000, 1:50,000, 1:100,000 and 1:2,50,000. When People's Republic of China was established in 1949, a new survey of China was undertaken because original base materials were transported to Taiwan by the previous government. Approximately 8000 sheets of 1:50,000 series had been produced which covered about a third of the country. However these were of somewhat inconsistent quality.

In 1956 a new National Bureau of Surveying and Mapping (NBSM) was set up. This employed the Bejing co-ordinate system of 1954. The control work was finished by end of 1978. The sheetline, numbering methods and symbolization of topographic maps were standardized which were similar to former USSR. Following series were used.

a) 1:25,000 For large towns and industrial zones.
b) 1:50,000 For other populated areas
c) 1:100,000 For desert and high mountains

The NBSM expanded & became fully operational in 1973. It implemented an extensive revision programme for

medium scales. In 1982 three large Bureaus together with numerous provincial Bureaus were setup and passed to Ministry of Urban & Rural Construction and Environment Protection. At that time about 80,000 personal were involved in various aspects of mapping. Priority was given to the large-scale surveys which resulted in the production of sheets at 1:10,000 and also photomaps. Even larger scales had been adopted for major towns in certain cases. By 1990 approximately 1,65,000 sheets on large scales covering built up areas had been completed. It also finished the topographical mapping of the entire country on 1:50,000/1:100,000 scales.

China has adopted digital technology since 1990 for converting the maps in digital form. National Topographical Data Base on 1:50,000 scale was created in 2005. This task involved 10,000 people from 100 different organizations. It was coordinated by NBSM and was completed in eight years. Besides vector data, this dataset includes raster maps, imageries (including 1m resolution imageies for cities), terrain, landcover and meta-data.

Chinese topographical maps except general-purpose geographical maps and tourists maps are generally not available to general public. The government is providing geo-spatial data to the industry on need base.

Australia

In Australia topographic mapping was undertaken by Commonwealth and State government mapping organizations. In 1945 National Mapping Council was created by agreement between the Commonwealth and State governments. Its function was to co-ordinate Commonwealth and State mapping activities. In 1966, metric scales were introduced.

By 1967 the whole of Australia was covered by aerial photography for the first time. The medium scale contoured mapping covered a reasonable area. In year 1968, 1:250,000 scale planimetric map series was completed. Relief on this sereies was generally shown by spot heights and hill shading. However 20% sheets were contoured.

In 1967, compilation of 1:100,000 scale National Topographical Map Series (NTMS) commenced. Relief was generally depicted by 20 meter contours. It was published by Commonwealth Government with some assistance provided by the States. There are 3065 sheets in this series. Compilation of this series was completed by 1988. Initially the publication programme had been restricted to 1646 sheets along with the coastal margins of the continent and island state of Tasmania. The interior of the continent was compiled at 1:100,000 scale but published at 2,50,000 scale. This was completed by 1986.

In 1975 the publication of the 1:2,50,000 scale National Topographic Map Series commenced. Sheets in this series depict contours at 50 meters interval. The 1:2,50,000 scale NTMS is published to civilian specifications and a parallel 1:2,50,000 scale Joint Operations Graphic series is produced for defence requirements. All of the 541 sheets required at this scale were completed by 1989 in both the series.

Now topographic maps at scales of 1:50,000 and 1:25,000 are produced by Commonwealth and State government mapping organizations. Coverage at these scales is generally confined to the closer settled areas and other places of specific interest. The State mapping organizations also undertake mapping at scales of 1:10,000 and larger for cities and other fast developing areas.

Now Geoscience Australia is responsible for producing topographic map products with a national coverage. The NATMAP product brand refers to Geoscience Australia's new 1:100,000 and 1:2,50,000 scale paper map products. The GEODATA product brand refers to its structured digital GIS and mapping data product at scales between 1:2,50,000 and 1:1 million. Now 1:2,50,000 is the largest scale at which National Digital Topographic Data Base exists for entire continent. It is available in different themes and contains a number of feature classes. Large-scale digital data is available for developed areas. Most of the digital products are priced and are licensed for use and available to users without any further restriction.

Conclusion

Topographical mapping evolved as one of the tools of colonial powers to serve their interest. Afterwards it became essential for armed forces for planning and execution of their operations. This brought the attribute of 'secrecy' attached to it during 18th, 19th and early 20th century.

Applications of topographical maps for developmental activities had started gaining importance from last century. Independent experts calculated that around 10% of Great Britain's economic activity is dependent on Ordnance Survey (NMA) data. It is about 136 billion pounds worth of economic activity in Britain.

With the advent of GPS, total stations, digital photogrammetry, digital cartography etc. all the stages of map making have become automatic, very easy, flexible and fast. Now the demands of user community is also changing. They want multilayered, current, complete, consistent and accurate data on larger scale, tailored for their use. Therefore concept of National Spatial Data Infrastructure is being developed in many countries.

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SEISIMPACT System

A web-based GIS System that can be used for management and evaluation of the records of reported damage in buildings connected to the occurrence of earthquakes

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GREECE has suffered many times from big earthquakes that caused human victims as well as big damage to public and private infrastructure. However, the 1978 earthquake in Thessaloniki (Mw = 6.5) motivated the beginning of a more systematic confrontation of the impact of such phenomena. This happened because it was the first time that a powerful earthquake affected a big modern city of roughly one million of residents. Thessaloniki presented the formal characteristics of Greek urban built environment: buildings with 4 to 8 storeys, large population in numbers and density, mixed land use, traffic problems and lack of effective planning of management of natural catastrophes. After the Thessaloniki earthquake, a situation of chaos was created due to the panic, the destructions, the lack of information and the innumerable calls on help, but also on control of static condition and damage of buildings. By that time, there was no specific procedure for the inspection of buildings and infrastructure. However, after the first period of embarrassment, the state agencies reacted. Inspection forms were designed, printed and distributed during the first days after the earthquake. The buildings were inspected by two-member teams of civil engineers in order to be classified in categories with regard to their damage and usability. These paper inspection forms constitute a valuable database concerning the impact of the earthquake to the buildings of Thessaloniki.

Fig. 1. Typical SEISIMPACT-THES display on user's screen (in Greek)

The evaluation of damage to the built environment can be carried out with the application of GIS (Bouma and van Groenigen 1995). Post assessment and analysis of structural damage typically involves geographically distributed parameters. Results and conclusions can only be reached by overlaying these spatially distributed parameters with the observed damage. Moreover, scenarios can be studied about the ways earthquakes or other natural disasters may affect the built environment.

The SEISIMPACT system

On the basis of the above discussion, a Web-based GIS System was developed in the framework of the SEISIMPACT project for the organization into digital form and the evaluation of the records of reported damage in buildings connected to the occurrence of several types of disasters. For a pilot application of the system, inspection forms of roughly 50,000 buildings after the 1978 Thessaloniki earthquake were utilized, along with seismologic, topographic, geological and geophysical data of the metropolitan area of Thessaloniki. SEISIMPACT was a project financed by the Hellenic General Secretariat of Research and Technology (Ministry of Development) (Savvaidis et al. 2004a, Koutoupes et al. 2004, and Savvaidis et al. 2005).

The SEISIMPACT Web-based GIS System is based on ESRI's ArcGIS and ArcIMS software and is making use of a detailed digital map of Greece focusing on the greater Thessaloniki area (fig. 1). The structure of the main database of the SEISIMPACT System was based on the design of paper inspection forms used for post- or pre-seismic control of buildings by the Civil Defence Authorities and the Earthquake Planning and Protection Organization of Greece, and a survey of possible damage to structures by different

Table 1 – Structure of the SEISIMPACT-THES database concerning the observed damage of a particular building

Field code	Description	Input value
A5.1	Safety classification of building	K1=Green K2=Yellow K3=Red K4=Collapsed
A5.1a	Valid only for part of building	K1=Yes, K2=No
A5.2a	Damage to plaster	K1=Yes, K2=No
A5.2b	Damage to brickwork	K1=Yes, K2=No
A5.2c	Damage to slates	K1=Yes, K2=No
A5.2d	Damage to beams	K1=Yes, K2=No
A5.2e	Damage to pillars	K1=Yes, K2=No
A5.2f	Damage to concrete walls	K1=Yes, K2=No
A5.2h	Damage to roof	K1=Yes, K2=No
A5.3	Number of unusable households	Number
A5.4	Access to certain parts of building denied	K1=Yes, K2=No
A5.5.	Disconnection of facility networks	K1=Electricity, K2=Water, K3=Gas
A5.6	Elements that must be urgently pulled down	Short description

natural or man-made disasters (Savvaidis et al. 2004a). It contains a detailed index of different types of damage that buildings may suffer due to several reasons, as shown in Table 1 (Savvaidis et al. 2004b). The design of the SEISIMPACT-THES database is flexible enough to allow the recording of various types of damage from various exterior reasons to buildings and, particularly, the input of data from existing files related to a past earthquake occurrence anyplace in Greece along with the Thessaloniki data.

A Web-based entry tool has been developed for the quick and reliable input of data details in the database (fig. 2). In this way, a valid Internet connection and a portable computer are only needed in order to record damage data from anyplace at anytime. The digital map displays city blocks and roads as well as different municipality boundaries including detailed demographic data and vulnerable sites (hospitals, schools etc.). Addresses of buildings whose damage has been stored in the database are linked to their geographical location on the map through an address-matching procedure (fig. 3). Additional layers of information include soil properties, as well as seismological and geotechnical data, such as historical and instrumental seismicity (fig. 4).

Spatial analysis based on the combined use of geographic and descriptive data may result into an evaluation of the structural reliability of the buildings. Spatial queries involve several types of questioning, such as safety classification (Green: Usable – no serious damage, Yellow: Temporarily unusable – with damage, usable after

Fig. 2. Web-based entry tool of the SEISIMPACT-THES System (in Greek)

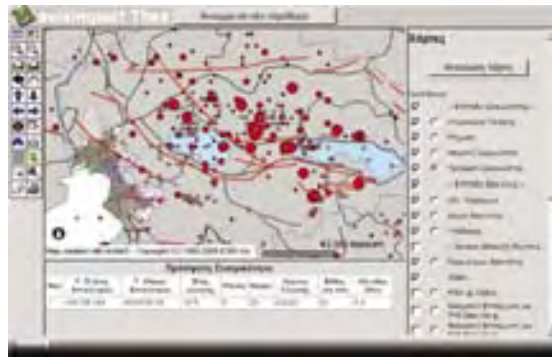


Fig. 4. View of the area of Thessaloniki along with soil-types, recent seismicity and geologic faults (in Greek)

Fig. 3. Location and post-earthquake building safety classification (Green: Usable – Yellow: Temporarily unusable – Red: Unusable, dangerous) (in Greek)

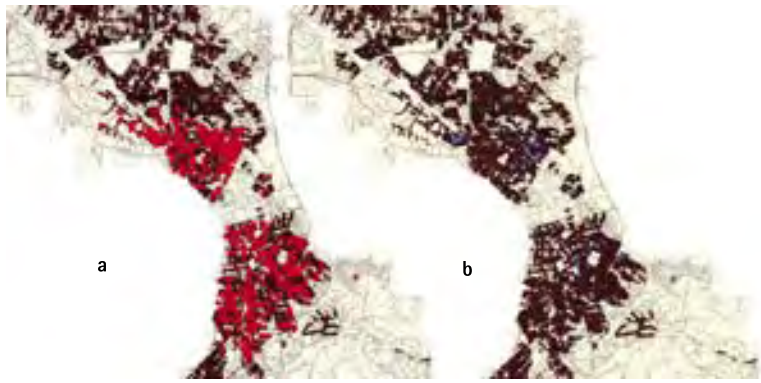


Fig. 5. Location of buildings that suffered heavy damage (a) and location of buildings that collapsed (b)

Fig. 6. The field recording system for near-real-time feeding of damage data to the SEISIMPACT System

the repairs, Red: Unusable – dangerous) of a specific building (or buildings in a region) (fig. 5), locations (buildings) at which a specific type of damage had occurred, correlation of different types of damage to the structural characteristics and use of buildings and other.

Finally, a field recording system was tested for near-real-time feeding of damage data to the SEISIMPACT databases. The system consists of a PDA computer equipped with a GPS receiver and a digital photo camera (fig. 6). The PDA can sent e-mail through a Bluetooth connection to a mobile phone. ArcMap software was used for the creation of cartographic data and the location of buildings was measured with the help of the GPS receiver. Furthermore, the main database of the SEISIMPACT System was loaded in the PDA, so that all information concerning a building could be input in an ArcGIS .shp file fully compatible with the System (fig. 7). The prominent use of the system is the capability of sending the .shp file (with attribute data and pictures, if necessary) to the SEISIMPACT server from time to time where it can be added to the existing database.

A tool for seismic risk management

In the case of earthquakes, the Civil Defence authorities must develop, test and be ready to implement an effectual action plan. A critical item in risk management procedures and the efficient confrontation of emergencies is the estimation of the potential damage that would be caused by a hypothetical earthquake or other disaster to the inventory of the city's structures and infrastructure. For this task, scenario earthquakes could be used to identify urban areas that present an increased possibility to be damaged in each hypothetical case (Kiratzi et al. 2004). In this way, the seismic behaviour of the city's structures (and infrastructure) can be estimated and response activities can be more accurate and well-organized.

Damage estimation leads to the knowledge/awareness of the extent of damage, which the city will incur if the scenario earthquake were to occur in the city. It is possible to know not only the total amount of the damage but also the weak points of the city through the analysis. This information is very important to manage effective seismic disaster reduction measures, including preparedness, emergency response activities, and seismic retrofit and recovery actions and policies.

Another important factor affecting the efficiency of a response action plan is the location, organization and accessibility of the evacuation sites and shelter camps. In the city of Thessaloniki there are areas that are expected to be used only as evacuation areas, other areas where camps are planned to be constructed for the population and areas that can be used in both ways. These sites can be included in the SEISIMPACT System, where an evaluation and re-organization of post-seismic response actions concerning them can be also done.

For every one of these sites, data concerning vital elements for their usability are obtained and input in the SEISIMPACT system. This descriptive information is composed of more than 80 fields including (Axioti et al., 2005): Geometric data (area, perimeter etc.), administrative and organizational information (Name of person in charge, communication data for municipality offices responsible etc.), demographic data (number of families, population per city block etc.), infrastructure of the area - planned to be operational in short

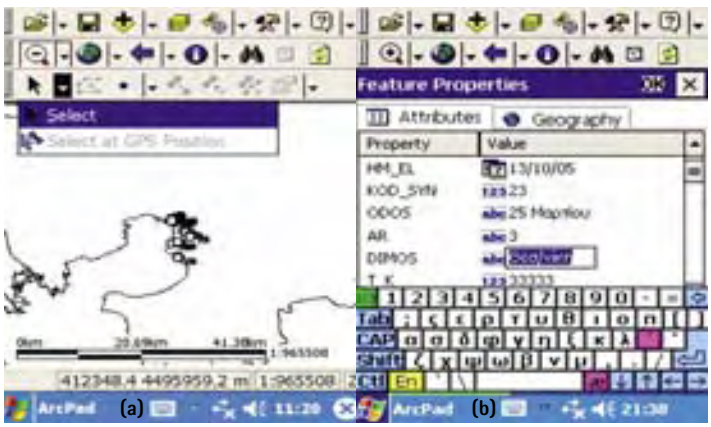


Fig. 7. PDA display concerning location of inspected buildings (a) and data input into the main database of the system (b)

Fig. 8. Example of the organization of an area served by a particular shelter site

Fig. 9. Priority of city roads that must imperatively be kept open after an earthquake event

term - (lifelines and critical facilities, medical installations, water, sanitation, electricity etc.), information about the number of people that can be using a specific area, security information (access and emergency exits etc.), information about cooking facilities and food supply, information about medical facilities and pharmacy, etc. An evaluation of each site can be done on the base of the above data contributing to the effectiveness of meters for prevention, mobilisation, action and confrontation of the devastating phenomena. Fig. 8 shows an example of the organization of an area served by a particular shelter site along with information about the population that is planned to be guided there in case of emergency. Additionally, fig. 9 shows the priority of city roads that must imperatively be kept open after an earthquake event in order to facilitate the traffic of emergency vehicles.

Conclusions

The SEISIMPACT Web-based GIS System can be used for management and evaluation of the records of reported damage in buildings connected to the occurrence of earthquakes. It allows multiple queries and processes to study in depth the behaviour of buildings in a place, and its correlation with other geological, geophysical, seismological, and geotechnical factors. A detailed evaluation of the observed damage in the buildings of a city can be done taking into account the spatial distribution of different types of damage. The homogenisation and harmonization of the relative technological tools of Information and Communication is further enhanced with the design of compatible databases for the recording and management of damage. Near-real-time damage recording is also provided through the capabilities of the system.

The public authorities concerned with the relief of earthquake impact have the possibility to record and retrieve important information regarding the static behaviour of buildings and facilities as well as the expected damage according to several scenario earthquakes, all web-based.

The complete paper with references can be viwed/downloaded at www.mycoordinates.org

GPS enabled Mobiles reclassified

In the May 2007 issue of Coordinates, we published a circular related to the reclassification of higher technology featured mobile phones by Central Board of Excise and Customs, Government of India. This meant that the GPS/ GPRS enabled mobile phones will face a 4% custom duty rather than 34% applicable on satellite phone. Three experts speak on the issue.

A case of misclassification

Pankaj Mohindroo
President, Indian Cellular Association

IT was never 34%. It was just a misclassification issue which erupted in one of the accounts. So there was never any question in our minds that it was not 4%. And we have a very good infrastructure and political leadership in the UPA government. They were very responsive and we were quickly able to get the clarification across to everybody. The fear was that if this misclassification or this confusion had erupted, what would have happened was that obviously the consumer cannot take a 34% price increase so it would have become a grey market unit and the product would have started coming in from the grey market.

Such development will help the LBS industry. There are three aspects of LBS in my mind. One is essential location finding, which is security related to our parents and children. Like I am worried about my child so I would always like to know where my child is. And the mobile industry has many live solutions for that. The second is corporate and business related location based services. The third is mobile marketing location based services which will give the real lease of activity to this industry. There you will be able to hunt for things which you need and you get special offers on that. So you're attracted to hunt for them. So I think LBS marketing will be the biggest thing.

Cellular services are expected to benefit immensely

T V Ramachandran
Director General, Cellular Operators Association of India

CELLULAR services are expected to benefit immensely from the reduction in Custom Duty on GPS enabled phones. With this reduction, the prices of these high end mobile handsets are expected to drop sharply.

This would give a boost to the sale of these handsets, especially for the business travelers, tourists and people who are just tired of their poor sense of direction.

The increased sale of such handsets would also benefit the Service Providers as now the number of users for the GPS service would increase, which would also enable service providers to offer these location based services at more affordable rates and hence benefit the end-customer by way of reduction in tariffs.

Relief to the privileged

Ashu Pandey
Managing Director, SiRF India

THE recent circular by Central Board of Excise and Customs, Government of India (Circular No. 17/2007-Cus F. No. 528/26/2005 – Cus (TU) classified high technology featured mobile phone having GPS as a secondary feature as a mobile phone. This circular is welcome news at a time when the Indian market for location based services is growing dramatically. Unfortunately, the order failed to deliver to the masses.

By this order, the government unintentionally created a dual stature in the market for GPS. While integration of GPS in mobile phones (cellular to be precise) will be accorded the same stature as a mobile phone, GPS use in other products will still be classified as radio navigational aid apparatus.

In so doing, the government gave relief to the privileged – those that could afford to purchase a mobile phone costing more that 20,000 Rupees. At the same time the government kept much needed products in the census, safety, security, and even pure navigational category at the high rate of duty (34%) – out of reach of average users.

We as an industry need to advise the government to the tremendous advantage usage of GPS brings into the lives of its citizens. From responding to an emergency to managing the nation (homeland security) GPS usage is on the rise, from Telematics to road tolling the applications are numerous. All these devices have been kept outside of the new circular and will continue to be classified as Radio Navigational Aid Device.

GPS has come a long way. More GPS chipsets are sold into consumer and automotive applications in a year than the total produced till date for radio navigation.

In the last few years, Government of India has taken concrete steps in making GPS accessible to the masses. It first declassified GPS from other radio navigational devices making the import of GPS receivers simple. It has now followed by reducing the duty tariffs on GPS receivers in mobile phone. It will be prudent for the Government to weigh the tremendous economic growth impetus use of GPS can have in the government and enterprise sector and reduce the duty from 34% to 4% across the board for GPS receivers.

Leica Geosystems launches Leica GMX901 GPS antenna

Leica Geosystems has launched Leica GMX901 GPS receiver with an integrated antenna for geodetic monitoring of sensitive structures. It streams single frequency code and phase data up to 1 Hz, providing the basis for position determination and deformation analysis.

IMAGINE InSAR released

Leica Geosystems has also released IMAGINE InSAR (previously known as IMAGINE IFSAR DEM), which enhances the ERDAS IMAGINE Radar Mapping Suite 9.1. For this, Leica has developed a strategic relationship with the Remote Sensing Technology Institute of the German Aerospace Center. *www.leica-geosystems.com*

Hemisphere GPS introduces Crescent V100 series GPS compass

Hemisphere GPS, Canada has introduced its new Crescent V100 and V110 GPS Compasses. These Vector products provide heading and positioning for marine navigation and a variety of other applications. It also features a smart antenna design. It combines Vector board and two multipath-resistant antennas, all housed in a half meter length enclosure for simple installation and portability. *www.hemispheregps.com*

Trimble makes it easy to update maps from the field

Trimble introduced field revision management and GIS redlining capabilities for its Trimble Fieldport software. The software is a Web-based, wireless software suite for utility field service management and location-based mobile mapping. It integrates GIS and GPS positioning data with customer and asset information for mobile workers in the utility, government and corporate sectors. *www.trimble.com*

SOKKIA announces the GSR2700 RSX GNSS Reference Station

SOKKIA, Japan has launched GSR2700 RSX GNSS Reference Station offering GPS + GLONASS RTK corrections and raw data to an unlimited number of rover receivers in the field. It comes equipped with a Windows XP based PC with 120 GB hard drive and 1.5 GHz processor speed and built-in Ethernet port. *www.sokkia.com*

u-blox announces free AssistNow A-GPS services

u-blox AG has announced the free provision of AssistNow A-GPS services. A-GPS benefits all GPS-enabled applications, especially those that require "always-on" operability such as fleet management applications or GPS-enabled handheld devices. *www.u-blox.com*

Spirent announces new software suite for GPS simulator

Spirent Communications has announced a new software suite for the STR4500 GPS simulator. The SimPLEX45 adds scenario generation capability to its replay-only STR4500 system to allow users to generate their own test cases based on motion-data that fits their specific requirements. *www.spirent.com*

Bluetooth GPS receiver supports A-GPS technology

Guangzhou Eurotronic Products Ltd, China has launched the GPS-009, a Bluetooth 1.1 GPS receiver that supports A-GPS technology. It uses SiRF StarIII chipset. *www.telecom.globalsources.com*

Magellan Maestro GPS devices offered

Motorists can have the Automobile Club of Southern California's travel expertise and roadside help at their fingertips with Magellan Maestro GPS personal navigation devices. Travelers can find their way quickly and easily to AAA-inspected and Diamond rated hotels and restaurants, AAA-approved auto repair facilities etc. Show Your Card & Save retail locations where member discounts are offered. *www.AAA.com*

NovAtel to supply CycloMedia with SPAN systems

NovAtel has signed a Supply Agreement with CycloMedia Technology BV (CMT) to integrate their two technologies and then deliver a minimum of 25 of its SPAN TM (Synchronised Position, Attitude and Navigation) systems plus its Inertial ExplorerTM post processing software over a 12-month period. The SPAN system - an integrated GPS receiver and IMU, with Inertial Explorer software - will be key technologies onboard the new CMT Digital Cyclorama Recording (DCR7) and Digital Cyclorama Processing (DCP) systems. *www.novatel.com*

Latest TomTom GO range unveiled

TomTom has revealed its new TomTom GO range like GO 720 and GO 520. It has features like daily map improvements, speech recognition etc. combined into one compact design, providing drivers with the ultimate driving experience. It has a new design with 4.3 inch touch screen having user interface with 3D graphics including building footprints. *www.tomtom.com*

HP expands Designjet compatibility with GIS software

The new HP Designjet T1100 and Z6100 Printer series are supported by ESRI's ArcPress Printer Engine for ArcGIS Desktop 9.2. HP and ESRI have aligned to ensure HP Designjet users have complete compatibility when using the ArcPress in ArcGIS Desktop. *http://h30267.www3.hp.com*

Topcon partners with GeoAge for data collection

Topcon Positioning Systems and GeoAge have announced an OEM partnership that will combine the Topcon's hand-held GIS mapping system – TPS' GMS-2, with FAST data collection and mapping software designed by GeoAge. *www.topconpositioning.com*

Samsung turns to Trimble GPS Clock for Ubicell

Samsung is incorporating Trimble's indoor GPS timing technology in its latest Ubicell system, a plug-and-play miniature wireless base station. It shall improve mobile coverage in the home by leveraging access-point base-station technology, called femtocell. It works by connecting to a mobile carrier's network employing broadband connection, creating a mini-cell in the user's home. It enlarges CDMA service coverage to homes in shadow areas and maximizes the frequency utility thus providing high-quality voice capabilities. Mobile handsets do not require any special technology to use the system; for security, up to four devices can be authorized to connect to the cell. *www.trimble.com*

AAMHatch to utilise Pictometry's imaging technology

Pictometry has signed a business agreement with AAMHatch of Australia. Under the terms of agreement, AAMHatch will get the right to utilize Pictometry's imaging technology to take digital aerial oblique imagery of Australia and New Zealand and to market these along with Pictometry's images in its library and softwares. *www.pictometry.com*

Matthew O'Connell receives Ernst and Young Entrepreneur award

GeoEye President & CEO, Matthew O'Connell, received the Ernst & Young Entrepreneur of the Year 2007 award for the Communications category. The award recognizes best entrepreneurs who are building and leading dynamic, growing businesses.

DigitalGlobe to cover an area 276000 sq km of US

DigitalGlobe has announced its second half of 2007 aerial flight plan with the commitment to collect more than 276,000 sq km of US aerial imagery at 0.3-0.4m spatial resolution. In its plan, more than 60 cities with populations greater than 50,000 will be covered, by leading DigitalGlobe's total planned new aerial markets to 668,000 sq km for 2007.

Rolta and Thales to start venture targeting Indian defence

The 51:49 joint venture between Rolta India and Thales will start operations soon. The venture targets at least 20-25 per cent of the defence market's IT solution requirements in India. It will focus on the Indian defence market with its offering of C4ISTAR technology (command, control, computers and communications systems, intelligence, surveillance, target, acquisition and reconnaissance) in India. *www.business-standard.com*

Blue Marble's GeoTranslate 5.0

Blue Marble Geographics releases GeoTranslate 5.0. It is Windows C++ vector file translation and feature manipulation tool, which may be easily embedded in custom GIS applications. Based on the GeoConvert component, GeoTranslate provides all of the original GeoConvert functionality and much more. *www.bluemarblegeo.com*

Rockwell Collins to provide GPS receivers for GB-GRAM program

The U.S. Army Communications-Electronics Command Life Cycle Management Command (C-E LCMC) selects Rockwell Collins to supply GPS receivers for the Ground-Based GPS Receiver Application Module (GB-GRAM) program. The total potential contract value of is $300 million. The government has already placed an initial $14 million order for GB-GRAM units. *djgosch@rockwellcollins.com*

Avenza announces Geographic Imager 1.5

Avenza Systems Inc., releases Geographic Imager 1.5 for Adobe Photoshop CS2 and CS3. It is the latest version of this powerful software that adds geospatial functionality to Adobe Photoshop. *www.avenza.com.*

Use of geographical data promoted in Japan by new law

Having recognized the great contribution of applications derived from data obtained through a combined use of GIS and positioning systems for a lot of valuable uses (cadastre, floods, spatial planning, statistics on old buildings, criminality rates etc.), the Japanese government decided to draft a law for the use of these data and to give guidance for orientation of future needs as well as for financial and human resources required. This will help avoid fragmentation of initiatives efficient use by different Japanese ministries. *www.gmes.info*

The SLA and NTU sign MoU

The Singapore Land Authority (SLA) and Nanyang Technological University's (NTU) School of Civil and Environmental Engineering have signed a MOU to conduct cooperative research and development, and education in the area of spatial information science and technology. This collaboration will eventually benefit industries such as real estate, national security, transportation, logistics, mapping and surveying. *www.sla.gov.sg*

The OGC announces new automated compliance tests

The Open Geospatial Consortium membership has adopted new test suites, test scripts and reference implementations for OpenGIS(R) Specifications. A new TEAM Engine (Test, Evaluation, And Measurement Engine) and Compliance Test Language were adopted as the OGC's official new compliance testing platform. *www.opengeospatial.org*

Businesses get free statistical information

Businesses in New Zealand will soon gain free access to a wealth of valuable statistical information that will help them identify growth opportunities and make better decisions. The first products to be released by Statistics New Zealand in August this year - Digital Boundaries and StreetLink - will enable businesses to develop market profiles, research likely sites and identify growth opportunities in particular locations. *www.scoop.co.nz*

Ordnance Survey improves rural mapping programme

An improved programme to update the most detailed mapping of rural Britain has been announced by Ordnance Survey. It shall improve a process called "cyclic revision" in rural areas, which involved systematic aerial photography "sweeps" at intervals of either five or ten years. The scheduling of sweeps will now move away from a purely cyclic basis to one led chiefly by intelligence on landscape change. *www.ordnancesurvey.co.uk*

ROLTA raises USD 150 million in international market

Rolta successfully raised USD 150 million in the international markets through Zero Coupon Foreign Currency Convertible Bonds (FCCBs). These FCCBs have a tenure of 5 years and 1 day, are convertible at a conversion price of Rs. 737.40 per share, representing a premium of 50 % over the closing price as on 21st June 2007 on the National Stock Exchange.

Indian land record management to integrate data on GIS

Government of India to consider the National Land Resource Management Programme (NLRMP). The programme aims at integrating satellite imagery, Survey of India maps and the land records on a GIS system. Although, construction and building activities will not be covered under the programme, once implemented, it would be able to provide Records of Rights (RoRs) with maps to scale. *http://economictimes.indiatimes.com*

Web based GIS project for urban development in Tamil Nadu

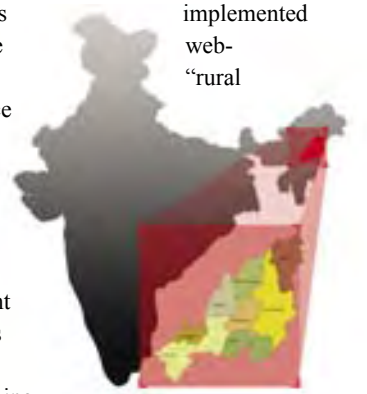
Work on the World Bank-funded Tamil Nadu Urban Development Project-III, for developing web-based GIS application for five urban local bodies in Tamil Nadu State of India, is likely to commence by mid-August covering Tiruchi, Coimbatore and Madurai Corporations and the Gobichettipalayam and Rajapalayam Municipalities. *www.hindu.com*

BISAG to set up Geoinformatics academy

The Bhaskaracharya Institute for Space Applications and Geo-informatics (BISAG) will set up an Academy of Geoinformatics in its premises near Gandhinagar in Gujarat, to promote and carry out research, impart education and training and also encourage the development of advanced Geoinformatics technology and applications. It will be affiliated to Gujarat University and the project will be funded by the State Science and Technology Department.

First web-GIS based 'Rural Surveillance System' in Nagaland

The Nagaland government's department of planning and co-ordination (planning branch) has implemented a statewide web-GIS-based "rural surveillance system". The system will help the government reassess its priorities, while drawing up policies to tackle poverty, health, education, land use, literacy and promote all-round rural development. The facility aims at making services like health and education accessible to people in rural areas. *http://nagarealm.com*



Tax in Indonesia

The Indonesian government plans to use imagery from DigitalGlobe's QuickBird satellite to identify taxable land. The imagery will provide a base map for property tax surveys conducted by the Indonesian Directorate of Property Tax and Ministry of Finance. *http://media.digitalglobe.com*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Galileo update

Galileo would be financed entirely by EU budget

The European Parliament adopted a resolution on the financing Galileo, saying all money must come from the European Union (EU) budget for the construction of the system. The parliament asked the European Commission, the executive body of the EU, to present a revised proposal for legislation on the financing of the Galileo program.

The parliament says it will oppose any solution which would combine EU funding with additional inter-governmental funding. The parliament expressed concern at the possibility that the additional financing necessary to fill the gap following the failure of the public-private partnership could be agreed on an inter-governmental basis.

The parliament also believed that if the public sector assumes the complete financing of the project, this factor should be taken into account in a future revised concession contract, especially as regards the reimbursement mechanism for public financial contributions and the prices of services.

Transport ministers from all 27 member states of the EU agreed earlier this month to build Galileo by public funding. But they failed to agree on where the funds should come from. The European Commission had to recommend entire public funding for the construction phase of Galileo in May as infighting in the eight-company consortium, which was picked to both build and manage Galileo, has put the completion date in doubt. *http://english.people.com.cn*

EU ministers agree more public funds for Galileo

European ministers conceded that a search for private-sector funding for the Galileo satellite navigation system had failed and that they would have to cough up additional cash from public coffers. But they fell short of agreeing whether the money to plug the 2.4 billion euro ($3.22 billion) shortfall should come from individual European Union states rather than the EU's collective budget, sources in the EU's German presidency said. "Everybody understood that the public-private way of (funding) deployment of the Galileo (system) doesn't work," a source said. "We need an alternative and that alternative is public procurement now. Everybody supports that idea." *http://investing.reuters.co.uk*

Real Time Traffic GPS Navigation Singapore

The first "Real Time Traffic GPS Navigation" beta solution is launched by MapKing in Singapore. It runs on Windows Mobile 5/6 Pocket PC phone devices equipped with 3G or GPRS wireless connection. Streamed from the intelligent transport system of Land Transport Authority, Singapore, Its real time traffic server dispatches traffic speed data to each device connected wirelessly on the road. At present, the data is updated every 5 minutes and the first generation covers highways and major roads. *www.mapking.com*

GPS aids harvest plans

U.S. agricultural researchers are developing an electronic system that can count fruit while integrated GPS receiver notes the position of each tree to help growers make better harvesting decisions. University of Florida experts said their technology called machine vision might be commercially available by the end of the decade. *www.sciencedaily.com*

GPS for prostate cancer

Experts say new technology is making it easier to track the position and motion of a patient's prostate with GPS-like precision during treatment. John Sylvester, M.D. of the Swedish Cancer Institute in Seattle says the way a prostate shifts during radiation treatment can make fighting prostate cancer a challenge. "From day to day, it can move different amounts, so we have always been stuck with treating more tissue than we want to treat, Dr. Sylvester says. *www.drkoop.com*

GPS devices implanted into birds to track migratory routes

In Taiwan, wild birds have been fitted with GPS devices to track migratory patterns. The Bureau of Animal and Plant Health Inspection and Quarantine under the Council of Agriculture, in collaboration with the wild bird societies of Taipei City and Tainan City, did this implantation. *www.chinapost.com.tw*

China makes breakthrough in multi-system GPS technology

China's first self-developed core chips of a dual-system satellite navigation positioning receiver, the SR8824, were recently tested and sanctioned by the country. Meanwhile, multi-system satellite positioning navigation receivers have also been put into mass production. This is a clear indication that China has made a breakthrough in the technology of the multi-system GPS and has mastered strategically significant core technology. *http://english.people.com.cn*

Russia not to wait for GLONASS phones

Telephones with the build-in GLONASS-module have no perspectives in Russia, most market participants believe. Sitronics the only domestic producer able to launch such telephones rejects their possible launching, saying the telephone will be too expensive and not in demand. At present the total number of simultaneously operating GLONASS satellites comes to 12. There are 17 machines in the system, 12 of which are operating, 3 are being maintained, 1 is to be launched, the other is to be withdrawn. Service availability in Russia comes to 59.7% (45.6% in the world).

Yury Urilich, Russian Institute of Space Device Engineering Director General said the first mobile phones with GLONASS were to appear at the end of 2007. Russian Institute of Space Device Engineering is the managing organization responsible for GLONASS commercialization.

Yury has apparently pushed on with GLONASS telephones launching. However, Sitronics Press Service did not confirm the information. Specialists believe, GLONASS-modules phones have no future even if launched. "Such phones design initiatives are mere talks in favor of government order, - Eldar Murtazin, - Mobile Research Group Senior Analyst says. – The module terminal has no perspectives in Russia. By the way there are no enterprises in Russia able to produce competitive phones". *http://eng.cnews.ru*

Google Earth urged to blur images of potential terror targets

New York state lawmaker Michael Gianaris called on Google Earth to blur views of potential terror targets on its maps. He said that the federal authorities need to work with Google to blur sensitive areas such as airports, chemical storage plants and military bases. The call comes after reported use of the site by the terrorists who were plotting to blow up a pipeline feeding JFK airport. *http://english.people.com.cn*

Ukraine plans satellite launch in 2008

According to the National Space Agency, Ukraine is planning to launch a Sich-2 Earth remote sensing satellite into orbit in 2008. The development of a "Sich"-based Earth observation system and a crisis-proof space monitoring system is part of The National Space Program of Ukraine for 2007-2011. Its first earth remote sensing satellite, Sich-1, was launched in 1995, and its modernized version, Sich-1M, in 2004. The Sich-2 project is being developed by Ukraine's Yuzhnoye design bureau with an estimated cost of $20 million. *http://en.rian.ru*

ISU plant pathologists detects soybean rust by satellite

Iowa State University, USA, researchers shall use satellite images to find Asian soybean rust. Using GPS, remote sensing and GIS, scientists can measure the green leaf area of soybeans to detect and identify diseases down to the area of a square meter. "Plant pathogens and pests impact the green leaf area index of crop canopies in different ways and those changes can be detected and quantified using remote sensing," said Forrest Nutter, professor of plant pathology. *www.wisconsinagconnection.com*

Google Earth layer helps mapping industrial pollutants

The environmental officials of Canada, Mexico and US have collaboratively launched initiative on tracking air pollution in North America introducing an interactive Google Earth mapping tool, which will expand public access to information on air pollutants. *www.cec.org*

TerraSAR-X launched

The German radar satellite TerraSAR-X was successfully launched on June 15th from Baikonur, Kazakhstan. The satellite will record new high-quality X-band radar images whilst circling Earth in a polar orbit at an altitude of 514 kilometres. It will carry out its task for five years, independently of weather conditions, cloud cover or daylight, and will be able to provide radar images with a resolution of upto 1 Mt.

India to launch military satellite CARTOSAT 2A

India will launch its first dedicated military reconnaissance satellite CARTOSAT-2A on a Polar Satellite Launch Vehicle rocket by the Indian Space Research Organisation in the first week of August, to give the country the capability to monitor missile launches in its neighborhood. It will be an advanced remote sensing satellite with a single panchromatic camera capable of providing scene specific spot imageries for cartographic applications. *www.india-defence.com*

ISRO to map tea gardens

The Tea Board of India is planning to tie up with the Indian Space Research Organisation for mapping the tea gardens. The mapping will generate garden-wise data on the actual extent of area under tea cultivation and also their location. It will also gather information on the extent of area available either for new plantation or for alternative cropping. The project would be jointly accomplished by officials of the Tea Board, Tea Research Association, and Regional Remote Sensing Centres. It will also enable the Tea Board to asses its various development schemes.

Asus launches PDA GPS phone in India

Asus launched the P535 tri-band PDA phone in India with full wireless functionality, GPS and auto-focus camera. It also offers push email, Internet access, off-site synchronization of calendar and contact information over wireless (802.11b+g) or mobile phone GPRS networks. *www.pcworld.in*

Mobile service turns cell phone into personal "Robo-Scout"

A new type of navigation service in USA called 'Earthcomber' spots personal needs or desires nearby. It works on phones with basic internet access, and provides GPS alternatives for phones without it. It can locate hundreds of different types of places and events, all arranged by distance to the individual's location.. The service is free, aside from data charges by wireless networks. *www.earthcomber.com*

Sony Ericsson's K530, HGE-100 for GPS navigation

Sony Ericsson has launched K530, its first GPS navigation capable handset. Its a 3G phone with web access, 2 megapixel camera and a variety other features. It's also the first phone to be compatible with the GPS Enabler HGE-100. *www.sonyericsson.com*

Beijing to use mobile phone positioning in Olympics

As part of its efforts to improve medical services for the 2008 Olympics, Beijing will adopt a mobile phone positioning system that can give the exact location of people calling about a medical emergency. The positioning system, already in pre-operation and expected to go into full service at the end of the year. *http://english.people.com.cn*

Benefon changes name, realigns company for LBS

Benefon, maker of Europe's Twig mobile phones and services, is now operating under the name GeoSentric. Benefon. It acquired LBS technology supplier GeoSolutions last month. *http://lbs.gpsworld.com*

Sony Ericsson chooses Wayfinder for navigation solution

Sony Ericsson has chosen Wayfinder as a supplier for its off-board navigation solution bundled with its GPS accessory HGE-100. This software does not feature 2D or 3D on screen navigation but turn by turn text commands and voice guidance. Tele Atlas shall provide the maps for Europe, North America and other territories covered by TeleAtlas. *www.wayfinder.com*

Yahoo expands LBS offerings, integrates GPS

Yahoo's latest software for mobile devices would feature GPS functionality, and its mobile services shall be available beyond the US. It offers a suite of mobile programs packaged in its Yahoo Go for Mobile software; it plans to release version 2.0 very soon in the US, which shall be available on various models of phones. *http://lbs.gpsworld.com*

Topcon will enter worldwide mobile control market

Topcon Corporation is expanding into international mobile control business, which will focus on measuring the exact positioning of virtually any mobile object on Earth for asset management and control purposes. This segment shall include Dynamic positioning (DP) of oil platforms and vessels, berthing navigation, Vehicle management and; Environmental research. *http://global.topcon.com*

Rx Networks launches GPStream GRN for AGPS mobile network

Rx Networks Inc., Canada, announces the availability of its GPStream Global Reference Network (GRN) solution for use in any Assisted-GPS (AGPS) mobile network. This service provides operators and service providers cost effective real-time GPS assistance data to drive their upcoming mobile GPS and LBS launch, including the latest SUPL standard-based services. *www.webwire.com*

Trakm8 integrates GPS products with Motorola secure radio network

Vehicle tracking technology provider, Trakm8 Ltd, UK, has partnered with Motorola to integrate its GPS tracking products with Motorola's Astro radio network. It has received contract wins for over 1,000 units. *www.bapcojournal.com*

Mobile phones pose threat to navigation market

Recent In-Stat research, Mobile Handset Navigation Applications May Threaten Global Personal Nav Device Market, covers the market for navigation/mapping services for mobile phones. It provides forecasts for subscribers and revenue for global mapping/navigation services by region through 2012. It includes extensive analysis of the consumer and business markets, current offerings for these services, with an outlook of the market's potential. Mobile phone operators now have the ability to market a downloadable navigation application that is just as good as, if not better, than personal navigation devices (PNDs), reports In-Stat. As a result, handset-based mapping and navigation applications could cause a major change in the overall navigation market, which is now dominated by relatively expensive standalone devices, the high-tech market research firm says.

The research also found that cellular operators whose service is based on CDMA (and iDEN) have an advantage over other mobile operators in nearly every region of the world, largely because of the A-GPS technology originally driven by mandates to support E911 services.

In-Stat surveys of US subscribers find navigation applications have a strong ability to draw subscribers from other operators and keep them loyal. It also found that the total number of mapping and navigation mobile phone subscribers could exceed 42 million worldwide by 2012. *www.instat.com*

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http://www.geospatial-exh.com/

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First International Summer School on Global Navigation Satellite Systems
Sep 02 - 09 2007
Berchtesgaden, Bavaria, Germany
heike.haas@unibw-muenchen.de

INTERGEO 2007
25-27 September, Leipzig, Germany
info@hinte-messe.de, www.intergeo.de

2007 Asia Satellite Navigation Positioning System Application Exhibition
25 - 27 September, Shanghai, China
nuogaisi2004@126.com

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Ft. Worth, TX
www.ion.org

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http://www.conference.co.nz/index.cfm/surveyors2007/

Nav 07 The Navigation Conference & Exhibition
30 Oct 2007 -01 Nov 2007
www.rin.org.uk, conference@rin.org.uk

November 2007

International Symposium on GPS/GNSS
05 - 07 Nov 2007, Johar Bahru, Malaysia

Trimble Dimensions 2007
November 5-7, Las Vegas
www.trimbleevents.com

ISG/GNSS 2007
6-8 November, Kuala Lumpur, Malaysia
md.nor@fksg.utm.my

4th International Symposium on LBS and TeleCartography
8-10 November, Hong Kong, SAR, China
http://www.lsgi.polyu.edu.hk/LBS2007/

ACRS2007
November 12-16, 2007, Kuala Lumpur, Malaysia
http://www.macres.gov.my/acrs2007

27th INCA International Congress
Visakhapatnam, India . Visakhapatnam
21-23 November 2007
http://www.hydrobharat.nic.in/lst_Circular_INCA_2007.pdf

ESRI South Asia User Conference 2007
29 - 30 November, Singapore
uc2007@esrisa.com
http://www.esrisa.com/pages/uc2007

BOOK REVIEW

Geographical Information System : Concept and Business Opportunities

By Dr Prithvish Nag and Dr Smita Sengupta
Concept Publishing Company, New Delhi, 2007, P. 520, Rs 1500 (HB), Rs 300 (PP).

A book on Geographical Information System pertaining to Indian conditions was long awaited. This book under review in a way tries to fill this void. The authors in the Preface have mentioned that the objective of this publication is to promote GIS technology in India. The language has been made simple in order to make the subject easily understandable. Though the book is designed for exploring business opportunities using GIS, but it may meet some requirements of a text book on GIS – however, the intention of the authors was not so.

Dr Prithvish Nag with Jack Dangermond at ESRI User Confernence

The book can be divided into two parts : (a) conceptual, and (b) examples of business models. A few chapters in the beginning and at the end are related to the history of development of cartography in India, GIS concepts, spatial data infrastructure and the like. The remaining chapters deal with different business models in GIS which have been successful however the degree may differ.

It is surprising to note that so much business can be generated with this technology. The GIS enterprise is not only restricted to this technology per se, but integration with other technologies such as remote sensing, soft photography, communication and information technology, has given a variety of options in developing business models. These applications can be in the fields of resource management, infrastructural development, public access, decision support system or law enforcement. However, most of the examples have been taken from abroad. Perhaps Indian case studies would have made this book more interesting to Indian business developers. Nevertheless, in the chapter on Status of GIS in India, tries to make up for this gap.

The book includes several appendices pertaining to the map policy, NSDI, GIS software, vendors, web addresses, recommended books and an exhaustive bibliography. There are several coloured photographs which enhances the quality of the publication. As claimed by the authors, if India is to become a hub for GIS BPO, this book will prove to be handy. There lies a great potential for generating employment in GIS in the country. This book will not only be helpful for business entrepreneurs but also for teaching in GIS.

The book is dedicated to Jack Dangermond, President ESRI for promoting all over the world.

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