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POSITIONING, NAVIGATION AND BEYOND

Positional accuracy enhancement

Interviews

James Doherty

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A cGIT publication

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Articles






Columns

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This issue of Coordinates is of 40 pages, including cover.

Planning planned cities

Delhi itself gives the glimpse of the status of cities of India.

The stress of increasing population, lack of basic amenities, the encroachment, the congestion, the mess…

Given the situation, worth attention is the ambitious National Urban Information System of the Ministry of Urban Development, Government of India.

It is claimed that this will help in town planning.

Started this year, the scheme envisages to develop GIS databases for 137 towns in 1:10,000 and 1:2,000 scales.

Deliverables also include utility mapping in 1:1000 scale for 24 towns, GPS data, etc.

The urban spatial data generation will be undertaken by the Survey of India.

Hope that one of the deliverables will be the transformation of Indian cities a better place to live in.

Sounds fascinating.

We wait and watch.

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"GPS has proven to be a boon to all the users"

James Doherty, President, The Institute of Navigation on emerging applications and technological innovations

Tell us about the Institute of Navigation?

The Institute of Navigation (ION) will celebrate its 62nd anniversary at its Annual Meeting next year (April 2007, Cambridge, Massachusetts).

I find the ION's purpose statement a useful starting point from which to describe this Institute: "The ION is a scientific, nonprofit organization, whose programs are directed toward advancing the science, art, and standards of navigation by coordinating the knowledge and achievements of practicing navigators, scientists, and those involved in the development and production of navigation equipment."

The Institute's membership includes about 3500 individual and nearly 100 corporate members, drawn from throughout the United States and Canada. In addition to the national organization, there are currently eleven active local chapters, which we call Sections, with several more in planning stages, plus a Satellite Division.

Any specific achievement of the ION.

I am particularly proud of the ION's work with students. This is largely done through the Sections. Most of our Sections have a Student Activities Committee. For example, my own Section in Washington DC has a program of activities with a number of local high schools, in which Section members assist various science teachers develop field projects to engage students in using positioning, navigation, and timing related technologies. The ION loans equipment and reference materials, and Section members serve as mentors with the teachers conducting and assessing field work. Favorite projects are surveying the school's athletic field with GPS and other equipment, and analyzing findings.

Other Sections, including Dayton Ohio and Rocky Mountain (Colorado Springs Colorado area), Alberta Canada, and Southern California, have programs to award undergraduate and graduate scholarships. Once awarded, although there are no strings attached, Section members frequently offer to mentor students in the study activities or onward research.

The ION Satellite Division has also created a number of lesson plans on positioning, navigation, and timing suitable for the junior high school (12-14 year old) level. These are available on the ION's website (www.ion.org).

The Dayton Section, supported by the ION's Satellite Division and several local sponsors, also runs the annual Autonomous Lawnmower Competition. The course is challenging—a fixed plot of grass, with obstacles (in known and unknown locations), an upper time limit for completion, a maximum speed limit, and a required technical presentation on (among other things) system affordability. Once started, the lawnmower must work complete the course autonomously, without manual or remote intervention. There are penalties for "cutting outside the lines," for failing to mow areas, for hitting obstacles, and for taking an optional restart. This year, I had the pleasure of watching five university teams compete, and the competition was heated. Ohio University's team won. However, I was most inspired when I talked with the students from all the teams—they had been particularly innovative in their integration of technologies, from simple dead-reckoning computing (based on compass and wheel revolution counters) to integration of carrier phase differential GPS with optical sensors and inertial measurement units.

You had been involved in the Maritime Differential GPS service for the US. Would you like to elaborate on this?

In my last tour of duty as an active duty officer of the United States Coast Guard, I was the Commanding Officer of the Navigation Center. When I arrived there in 1996, the Maritime Differential GPS (DGPS) had just achieved initial operational capability (IOC). It was largely installed and operating, but it had not yet been certified, and it was experiencing a few equipment problems and maintenance difficulties. There were standards in place for service operations and receiver performance, and we had a number of users. Over the next several years, the Navigation Center helped focus a Coast Guard wide effort to update equipment, standardize the sites, and certify coverage and system performance to mandated standards. In March 1999, the Secretary of Transportation and Commandant of the Coast Guard, in a ceremony at the Navigation Center, declared the Maritime DGPS fully operationally capable (FOC)–in other words ready for full use by mariners.

By the time of FOC for the US DGPS network, virtually all maritime nations of the world had installed their own similar service, operating to the same standards in their own critical ports and waterways. This made it possible for mariners to travel anywhere in the world, using GPS when in open water and taking advantage of the improved

accuracy and integrity of the DGPS when entering virtually any port.

What about nationwide DGPS expansion programme?

The Nationwide DGPS (or NDGPS) expansion began with a test station in the Pacific Northwest, which began operating in 1997. The test station filled a gap in maritime coverage in the upper reaches of the Columbia River and also provided coverage for terrestrial user tests, dominantly railroad users. As a result of the tests, the Department of Transportation made a decision to move forward with the NDGPS. The Federal Railroad Administration sponsored the system, with additional sponsorship by the Federal Highway Administration, and the Coast Guard agreed to develop, operate, and maintain the service as reimbursed by the other agencies. The NDGPS would be operated to the same standards as, and in concert with, the maritime DGPS service.

Most of the NDGPS sites were developed economically using decommissioned United States Air Force GWEN stations. These sites were nearly perfect for broadcast of the DGPS correction signals, and the site infrastructure was ruggedly built. It was relatively simple to add reference station and integrity monitor receivers, and then modify the signal generators to update a GWEN site to NDGPS operations. The first few NDGPS sites were also declared operational in the March 1999 FOC ceremony for the maritime service.

DGPS and NDGPS are specified as 10-meter accuracy systems, but in reality most users experience closer to meter level accuracies. There is a new variant, called High Accuracy NDGPS, or HA-NDGPS. Employing long range carrier phase corrections, it appears possible to upgrade the installed DGPS and NDGPS infrastructure for decimeter level accuracies nationwide. I am hopeful to see these developments occur.

Jim Doherty retired from the U.S. Coast Guard at the rank of Captain in 1999; his last duty assignment was Commanding Officer of the Navigation Center. Under his leadership, the Maritime Differential GPS service achieved full operational capability, the Nationwide DGPS expansion was initiated, and the first phase of Loran recapitalization was begun. He also served as Deputy Chair of the Department of Transportation's Civil GPS Service Interface Committee.

Jim is currently a Senior Analyst at the Institute for Defense Analyses, Science & Technology Division. Among his responsibilities, he serves on GPS Independent Review Team and the WAAS Independent Assessment Team.

He has served on the Council of the Institute of Navigation and in various elected national offices of the ION since 1999. He was Chair of the Washington DC ION Section from 2000 until 2005. In June 2005, he became the Institute's President, a position he will hold until January 2007.

What is your focus area of the work in Institute of Defence Analysis?

I retired from active military service with the Coast Guard in June 1999, and about two weeks later I began a second career with the Institute for Defense Analyses (IDA). It is hard for me to believe that I have been with IDA for more than 7 years. At IDA, I am a member of the GPS Independent Review Team. I also participate in or lead various reviews and assessments of position-navigation-time (PNT) and other technologies for the Department of Defense and on occasion for other Federal agencies.

What trends you see in the field of navigation in terms of technological innovations?

Very clearly GPS/GNSS has put navigation literally "on the map" for many users worldwide. The major trends I see include: increases in efficiency and safety in traditional maritime and aviation navigation applications; new applications in automobiles and personal navigation; increased demands for global position and time information to support new, non-navigation but navigation-related, applications; miniaturization of user equipment; and new integrations of user equipment.

In the Coast Guard, I served as navigator aboard a Coast Guard Cutter early in my career, and even earlier, as a cadet at the Coast Guard Academy, I sailed aboard a 44-foot sailboat in several ocean races. I was then part of an elite group of mariners and aviators who could call themselves "navigators." In those days, we used sextants, compass, fathometer, charts, and even though we had some radionavigation systems, such as radiobeacons and Loran-A, navigation was a tough-to-master, learned skill, which required constant practice to remain proficient. Later in my Coast Guard career, I was a circuit and system engineer working on the more modern Loran-C system, upgrading transmitter and receiver systems to improve performance and automate or remotely control operations. Still, the art and science of navigation remained the domain of the skilled professional.

Today those professionals have a new tool, more accurate than ever before, and more universally available—GPS. With the Wide Area Augmentation

System (WAAS) and other space-based augmentations, DGPS/NDGPS, new signals of GPS modernization, and companion elements of GNSS (Galileo, GLONASS, et al), not only do the navigation professionals have access to these services but so also everyone else. More and more people, with limited or no "navigation" training, are using the position and time information from this robust GNSS. For example, road maps have not quite disappeared from auto club shelves, but increasing numbers of drivers are relying on factory installed or after market GPS-based navigation systems.

So, with all that as background, what's next? Users demand new services, market forces generate innovations to meet those user needs and expectations. Sometimes users are disappointed with their new GPS-based services, for example when their automobile navigation system stops working in an urban canyon, tunnel, or parking garage. Some smart innovator then integrates the GPS unit with maps, odometer, and differential wheel counters to enable higher accuracy dead reckoning through the interruption in signal reception. I look for this type of integration within user equipment to continue.

Would you like to highlight some of the emerging application areas?

When people ask me this question, I like to turn it back on them … but with a bit of a hint. That is, how do you think having access to a globally consistent, precise and accurate, position and time grid will help you? Will, for example, having up-to-the-minute traffic information, keyed to your current position and planned route, be helpful? Or, how about having your cell phone call ahead to your home to reset the furnace or air conditioner and make other preparations for your comfortable arrival?

On a more serious note, highways are getting more crowded, as are all modes of transportation. At the same time, there is a continuing demand to move goods and people faster and more directly from point to point, and while also improving the level of safety. Intelligent transportation system (ITS) technologies will help increase automation to improve efficiency in transportation, and I believe if done right, improve safety.

Any specific issue you would like to raise?

You have seen my comment above about the student activities of the ION. When one of my sons graduated from high school (longer ago than I care to remember), I remember the graduation speaker's theme—"if you can dream it, in your lifetime you will have the chance to achieve it." That one line particularly resonated with me.

I knew then that some technologies I worked on enabled some dreams to become reality for my generation. I would like to see that same opportunity for future generations. To that end, I hope to see the ION and other professional organizations continue to have active student programs—to get young students interested in technology and what it can do to improve the quality of life … and to stimulate some of them to further their formal technology education to become the innovators of the future.

What is your perception about the Galileo initiative?

I believe that GPS provided a breakthrough capability—ubiquitous position and time information—that has led to major productivity and quality of life gains. Galileo will add robustness to the overall GNSS services, in that it will provide more satellites and thus improved geometry when users have a limited view of the sky. The key is that the services be interoperable, such that the sum is greater than the total of the parts.

Some the countries like India don't want to depend on US GPS. Please comment.

It has been Presidential policy since the 1980s that GPS be provided free of direct user charges for peaceful global use. There is even a law enacted by Congress to that effect. You are aware of the US-EU agreement on GPS and Galileo which also supports such a policy. In a democracy such as ours, I figure that is about as good a guarantee as one can get. Additionally, there are two formal user groups, those "professional navigators," which help assure consistent global quality in GPS and all GNSS services. That is, the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) set rigorous standards for the operation and use of GPS/GNSS in maritime and aviation safety applications worldwide.

Those are the facts. But let me add a few thoughts. It is not an inexpensive venture to develop, deploy, operate, maintain, and sustain a GNSS constellation of satellites. Yet it is clear from the widespread acceptance of GPS that it has proven a boon to all who would use it. GPS is not alone in providing GNSS services. GLONASS remains in operation, and Galileo has launched its first test satellite. Thus, there are definite indications that GNSS will become more robust. In that light, your question might be considered in benefit vs. cost terms—can countries afford not to take advantage of those services offered by others?

Finally, it is clear that through their own DGPS or WAAS-like space-based augmentation services, each country has the capability to establish the ultimate accuracy and assure the integrity of GPS and other GNSS for their own users. And, if a local or regional backup service were desired, there are several legacy radionavigation systems, such as Loran-C and modernized variants (e.g., "Enhanced Loran"), as well as mode-specific systems (e.g., VOR/DME), that would provide a measure of independence within critical infrastructures.

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Positional accuracy enhancement of an INS/DGPS integrated system

This article presents a novel cascade denoising algorithm to reduce the impact of short term INS errors and improve the positioning accuracy during GPS signal blockages using several INS/DGPS integrated navigation systems

KAI-WEI CHIANG, YUN-WEN HUANG, CHRIS GOODWALL AND NASER EL-SHEIMY

According to Skaloud [1999], the inertial sensor errors are composed of long term errors (low frequency components) and short term errors (high frequency components). Therefore, a conceptual plot of the frequency spectrum of the inertial sensor errors in the measurements can be illustrated as in Figure (1).

Figure (2) shows how each of the errors is reduced by the INS/DGPS integration process. The long term errors are reduced by updating the filter with the observed error state vector coming from the GPS filter (position and velocity). Certain amounts of the short term errors are reduced by the smoothing that is done by the numerical integration process of the INS mechanization [Burton et al., 1999]. However, Figure (2) indicates the benefits of the INS/DGPS integration are band-limited as the lower boundary of the error spectrum is mainly determined by remaining biases in the GPS observations while the upper boundary is mainly determined by short term inertial sensor errors.

Consequently, the remaining GPS biases contained within the GPS navigation solution, such as ionospheric delay, tropospheric delay and multipath, are responsible for the very long term errors illustrated in Figures (1) and (2). Due to restrictions set forth by the sampling theory, the utilization of DGPS data to reduce the short term INS errors is not effective since the sampling rate of DGPS measurements (1Hz) is much lower than those of an inertial unit. As a result, the long term INS errors that are reduced by the integration process with GPS are usually more significant than the short term errors [Skaloud, 1999].

The long term errors usually include accelerometer biases and gyro drifts which are commonly modeled as error states. Therefore, the impact of these long term errors for long periods of time can be limited with external aiding. On the contrary, the remaining short term errors remain and contribute to the error accumulation during GPS signal outage periods. Consequently, Figure (3) illustrates that a perfect denoising algorithm is expected to preserve the true motion dynamic signal and remove unwanted short term errors completely. In addition, Figure (3) also implies that the key element of developing the pre-filtering algorithm for removing unwanted short term errors is to investigate the bandwidth of the true motion dynamics sensed by each inertial sensor individually. Thus, the objectives of this article are to: (1) identify the motion dynamic bandwidth of a typical land vehicle sensed by each inertial sensor individually, (2) evaluate the performance of the proposed algorithm using various INS/DGPS integrated land vehicle systems, and (3) investigate the negative impacts of the cascade denoising algorithm on different INS/DGPS integrated land vehicle systems.

Spectrum analysis of IMU kinematic signals

Wavelet denoising algorithms have been applied to separate the low frequency (long term) and

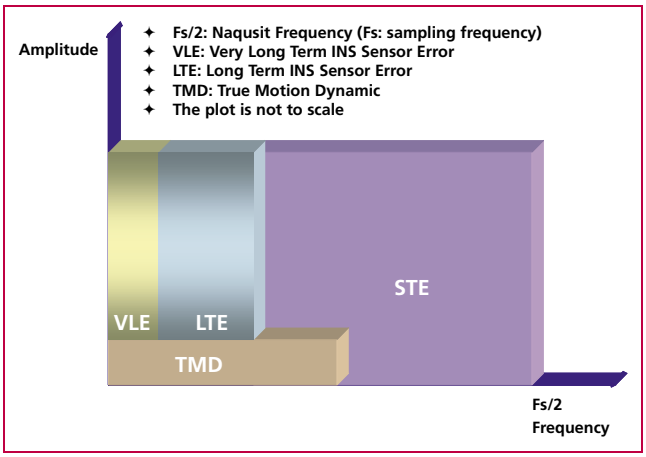

Figure 1: The conceptual spectrum of INS sensor errors (After Skaloud, 1999)

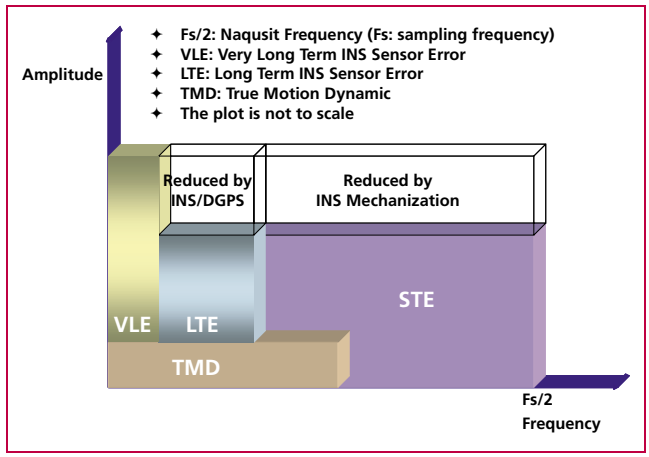

Figure 2: Conceptual plot of the INS sensor errors spectrum after INS/DGPS Integration

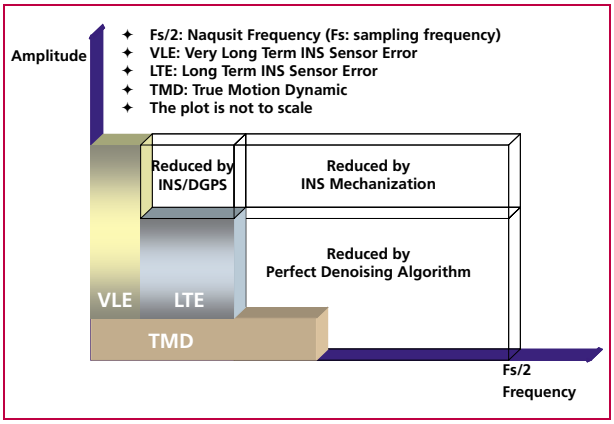

Figure 3: The conceptual spectrum of INS sensor errors (After Chiang et al, 2004)

high frequency (short term) error components of IMU signals. See Skaloud [1999], Burton et al., [1999], and Nassar [2004] for details. However, for land vehicle navigation applications the concern is in removing short term errors and improving the positioning accuracy during GPS signal blockages without jeopardizing the true motion dynamic components of the vehicle.

Indeed, such operation requires the prior knowledge of the true bandwidth for typical land vehicle motion dynamics and the spectrum characteristics of the wavelet denoising algorithm. Thus, the positioning errors, after applying denoised kinematic IMU measurements, can be expected to be smaller than those obtained through the use of original data if the true motion dynamic content can be well preserved and the short term errors can be removed during the denoising operation. Chiang et al., [2004] investigated the bandwidth of true motion dynamics using kinematic IMU raw measurements sensed by several systems and suggested the bandwidth of true motion dynamics for general land vehicle applications as given in Table 1. See Chiang [2004] and Chiang et al., [2004] for more details about the spectrum analysis of kinematic IMU signals. The cause for the wider bandwidth sensed by the X-Gyro, Y-Gyro and Z-Accelerometer was mainly due to road irregularities (i.e., bumps). In contrast, the narrower bandwidth sensed by the X-Accelerometer, Y-Accelerometer and Z-Gyro indicates a much smoother heading motion along the trajectory, which reflects the dynamic motion variation in typical land vehicle applications [Czonpo, 1990, Chiang et al., 2004 and Chiang 2004].

Table.1: Bandwidth of true motion dynamics

Sensor	Gyro			Accelerometer		
	W_x	W_y	W_z	A_x	A_y	A_z
Bandwidth	<8Hz	<8Hz	<2Hz	<2Hz	<2Hz	<8Hz

Traditional wavelet denoising

Mallat [1989] proposed Multiresolution Analysis (MRA), which has been the most common and general approach to constructing a wavelet basis. In signal processing, such an idea is implemented as subband filtering, or quadrature mirror filtering [Strang and Nguyun, 1997]. The decomposition step consists of a low pass *(h)* and a high pass *(g)* filter followed by downsampling *(↓ 2)* (i.e., retaining only the even index samples), see Mallat [1999] for more details about wavelet decomposition. Chiang et al., [2004] investigated the relationship between the decomposition level, sampling frequencies (i.e., Fs=200Hz, Fs=100Hz, and Fs=50Hz), and the stop bands of residual frequencies corresponding to the approximate signals through the spectrum analysis of approximation signals (A_i,$i=1, 2, 3...n$) and the detail signals (D_i,$i=1, 2, 3...n$) generated at each wavelet decomposition level, as indicated in Table 2.

The relationship presented in Table 2 was derived using Daubechies wavelet functions ($DB(i)$, $i=2 \sim 15$) [Daubechies, 1992].

Table 2: Relationship between stop bands and decomposition level

	Fs=200 Hz Stop band (Hz)	Fs=100 Hz Stop band (Hz)	Fs=50 Hz Stop band (Hz)
DL=1	64	32	16
DL=2	32	16	8
DL=3	16	8	4
DL=4	8	4	2
DL=5	4	2	1
DL=6	2	1	0.5

First Generation Wavelet Denoising Algorithm

The basic principle of the first generation denoising algorithm is to perform thresholding on the DWT of the noisy signal, and then take the inverse DWT of the thresholded coefficients to obtain the denoised signal. Donoho [1992] proposed the following schemes for denoising:

1) Suppose $x(n)$ is the original signal of length n, $y(n) = x(n) + e(n)$, where $y(n)$ is corrupted by $e(n) \sim N(0,1)$. Find the DWT of $y(n)$ which is called $Y_{j,k}(n)$.
2) Perform proper thresholding on $Y_{j,k}(n)$ using δ chosen based on Stein's Unbiased Estimate of Risk or Threshold choice (SURE) (see Donoho [1992] for details) , see Chiang et al., [2004] for details about performance of different thresholding algorithms.
3) Take the inverse DWT of $\hat{X}_{j,k}$ to recover the denoised signal $\hat{X}(L)$.

Second Generation Wavelet Denoising Algorithm

The DWT is not translation invariant (shift invariant), meaning that if a DWT is applied to a shifted version of a signal x, it cannot get the shifted version of the DWT of x [Lang et al, 1996]. The lack of translation invariance is not necessarily a problem for most applications, but for denoising this phenomenon introduces artifacts when using transform domain thresholding dependent on the kind of

Table 3: Optimal decomposition level for kinematic IMU measurements

	Fs=200 Hz BW/L	Fs=100 Hz BW/L	Fs=50 Hz BW/L
Wx	*8/4*	*8/3*	*8/2*
Wy	*8/4*	*8/3*	*8/2*
Wz	*2/6*	*2/5*	*2/4*
Ax	*2/6*	*2/5*	*2/4*
Ay	*2/6*	*2/5*	*2/4*
Az	*8/4*	*8/3*	*8/2*

transform domain one is working in [Jansen, 2001]. For wavelet denoising the artifacts are related to the behavior near singularities. In the neighborhood of discontinuities, wavelet denoising can exhibit pseudo-Gibbs phenomena [Coifman and Donoho, 1995].To reduce the impact of pseudo-Gibbs phenomena, the Undecimated Wavelet Transform (UDWT), which has been independently discovered under several names, e.g., shift/translation invariant wavelet transform (TIW) [Coifman and Donoho, 1996], stationary wavelet transform (SWT) [Nason and Silverman,1995] or redundant wavelet transform, can be applied.

Coifman and Donoho [1995] extensively studied the similar characteristics of the UDWT and implemented a so called Translation Invariant Wavelet Transform (TIW) based on the idea of Cycle-Spinning, or denoising all possible shifts of a signal and then averaging. The idea was originally explored to reduce the pseudo-Gibbs phenomena. If we let S_h represent the circular shift operator then for a signal X with length N, $S_h X(k) = X((k+h) \bmod N)$. Now if L represents the DWT operator, T represents the thresholding operator, S_h^{-1} and L^{-1} are the unshift and IDWT operators respectively, then the denoised signal is given by the following equation:

$$\hat{X} = \frac{1}{N}\sum_{h=0}^{N-1} S_h^{-1} L^{-1} T L S_h X \qquad (1)$$

The denoising procedure for IMU raw measurements is illustrated in Figure (4) where cA_i *(i = 1, 2, 3...n) and* cD_i *(i = 1, 2, 3...n)* are approximation and detail coefficients generated at each decomposition level. See Chiang [2004] for the relationship between approximation/detail signals and approximation/detail coefficients. The optimal decomposition level (L) varies with the bandwidth of true motion dynamics in each sensor. It can be chosen using Table 2 and the bandwidth of the true land vehicle motion dynamics listed in Table 1, which is given in Table 3.

Chiang et al., [2004] indicated that the major limitation of applying either the 1st or 2nd generation denoising algorithms was the remaining high frequency components. The conceptual plot of the frequency spectrum of both the 1st and 2nd generation denoising algorithms is given in Figure (5). Therefore, the remaining issue involves removing the short term errors whose frequencies are higher than the stop band and reducing the short term errors whose frequencies are lower than the stop band when the existing wavelet denoising algorithm is applied to the IMU signals.

Development of the cascade denoising algorithm

As indicated previously, through a spectrum analysis of the DWT/TIW denoising algorithm and kinematic IMU signals, the bandwidth of the true motion dynamics sensed and the stop band of the wavelet-based low pass filter can be determined as given in Tables 1 and 2. As a result, an optimal decomposition level of the wavelet-based low pass filter was determined. Since the signals whose frequency ranges are outside the bandwidth of the true motion dynamics are undesirable, wavelet-based low pass filters with optimal decomposition levels (L) can be applied for each sensor. These low pass filters are first used to remove undesirable high frequency components whose frequencies are higher than the stop bands and then applied to filter any remaining short term errors whose frequencies are lower than the stop bands of the low pass filters, as shown in the Figure (6).

Through this spectrum analysis of the cascade denoising algorithm, the above mentioned limitations of the traditional denoising procedure can be removed. In addition, the cascade denoising is able to provide superior performance over traditional denoising algorithms

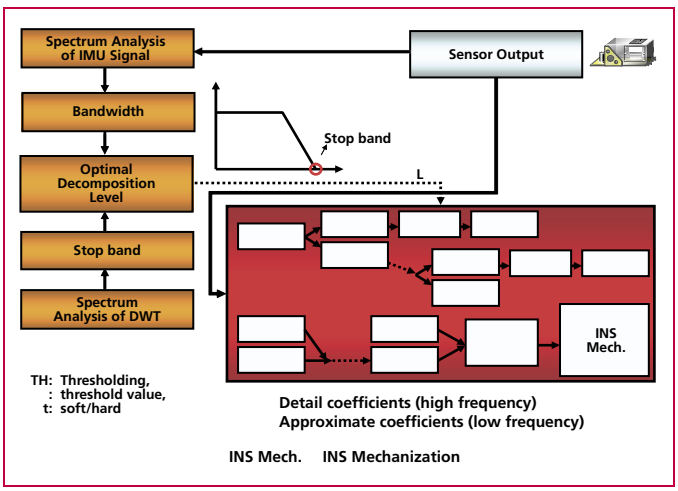

Figure 4: IMU kinematic signal denoising

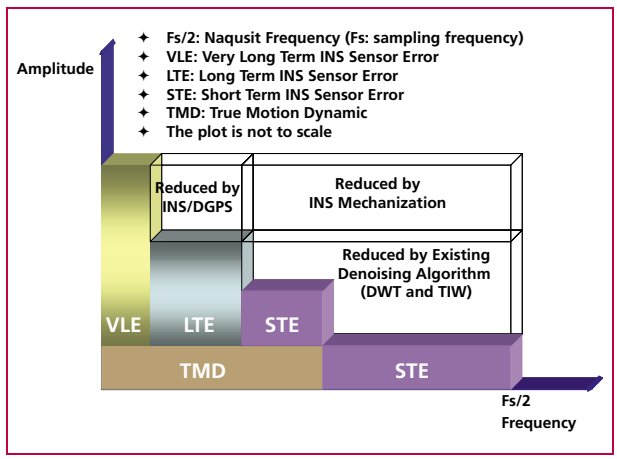

Figure 5: The conceptual spectrum of INS sensor errors after denoising

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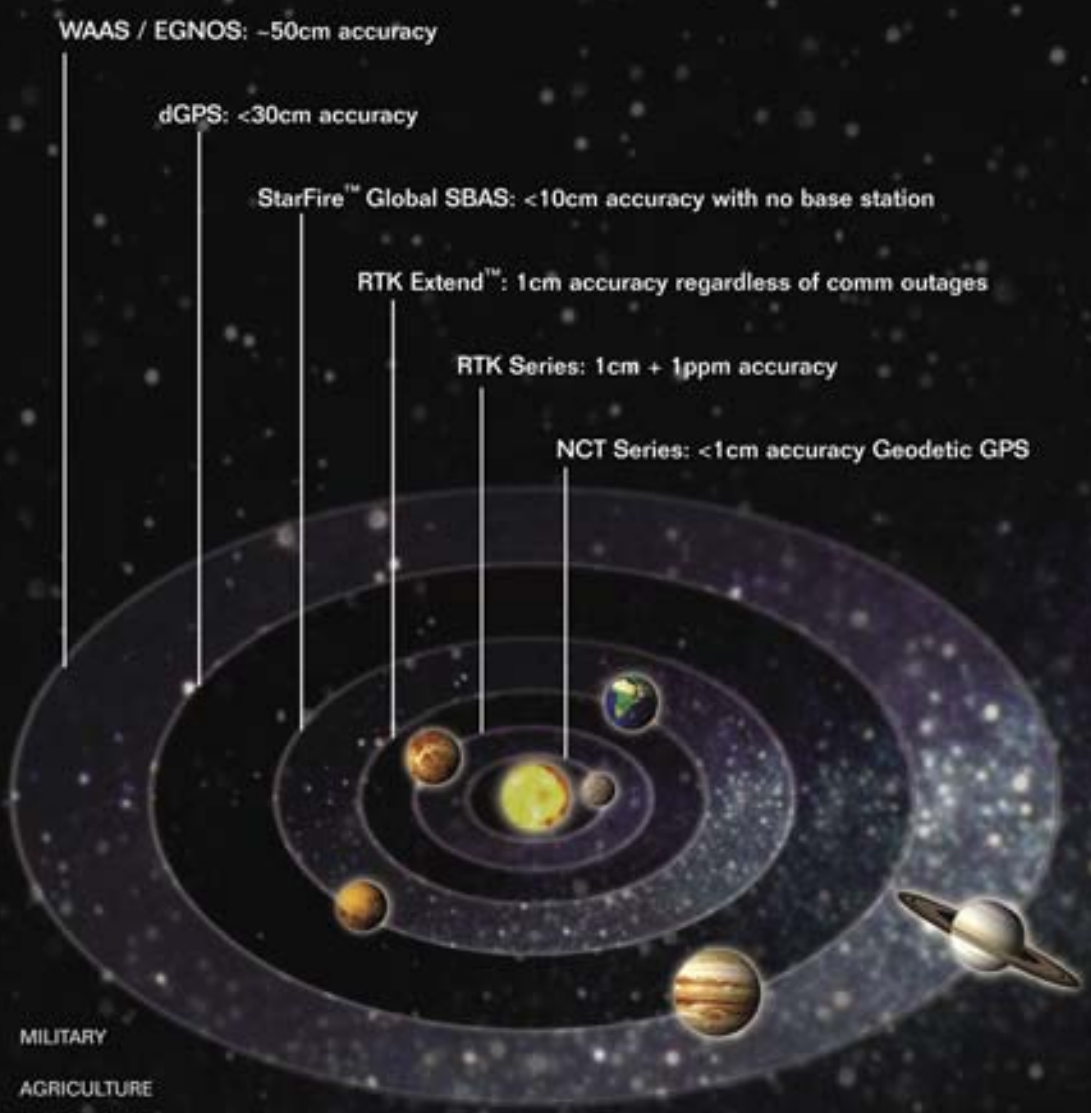

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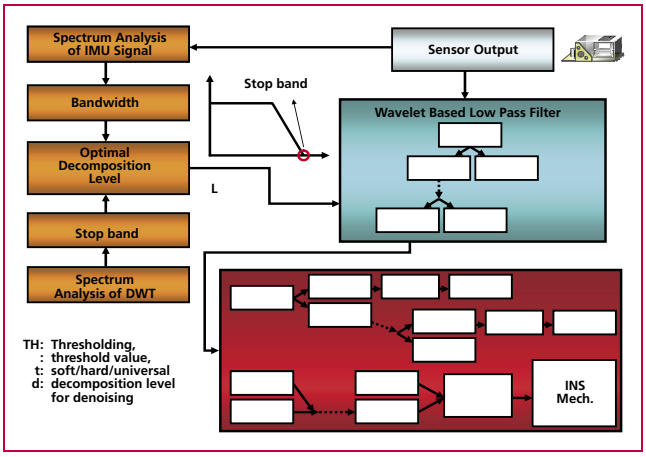

Figure 6: IMU signal cascade denoising

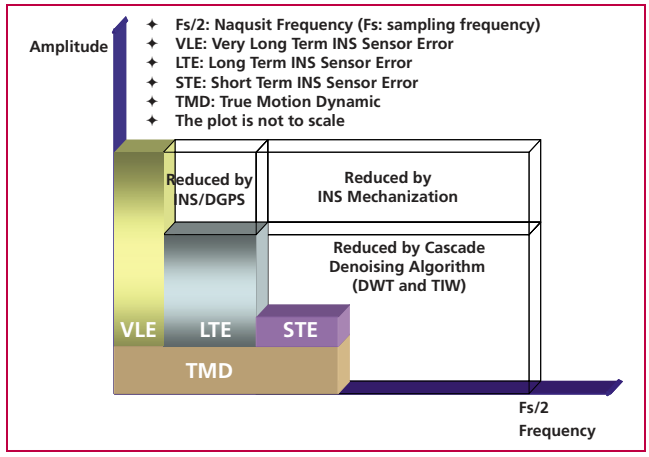

Figure 7: The conceptual spectrum of INS sensor errors after cascade denoising

in the position domain. The conceptual plot of the frequency spectrum of the cascade denoising algorithm is given in Figure (7). Comparing Figure (3) to Figure (5) and Figure (7), the spectrum of the cascade denoising resembles that of a perfect denoising algorithm. This implies that the cascade denoising is superior to traditional algorithms in the frequency domain. Furthermore, Chiang et al., [2004] showed that the cascade denoising is superior to traditional denoising algorithms in the position domain since it is capable of providing significant improvements in terms of the positioning accuracy during GPS outages.

Results and discussions

To asses the performance of the proposed cascade denoising algorithm a field test was conducted in October 2003 by the Mobile Multi-sensor Systems (MMSS) research Group of the University of Calgary. The test was conducted to replicate a typical land vehicle environment using three different INS/DGPS integrated systems consisting of a navigation grade IMU (Honeywell CIMU), and two NovAtel OEM4 receivers. The performance of the cascade denoising algorithm was then evaluated in terms of the IMU qualities (i.e., accuracy levels). Figure (8) illustrates the test van and the set up of the IMU systems used in the test.

The reference trajectory was generated using the CIMU/DGPS integrated system with a loosely coupled extended Kalman Filter integration scheme. There were no natural GPS signal outages in this test trajectory, and therefore, eight simulated GPS signal outages were simulated by removing the GPS solutions being fed into the INS Kalman filter during the integration process, see Figure (9) for the location of the simulated outages along the test trajectory. The navigation solutions obtained through the use of raw IMU measurements and denoised IMU measurements were then compared with the reference trajectory.

Figure (10) and Table 4 provide summaries of the positional error performances when comparing the denoised INS/DGPS integrated navigation solutions to the raw INS/DGPS integrated navigation solutions using a navigation grade IMU with the reference trajectory during each GPS signal outage period. It can be seen from Figure (10) that the cascade denoising algorithm was able to provide visible improvements during several GPS outage periods. As indicated in Table 4, the positional errors of six GPS outage periods were successfully reduced using denoised CIMU measurements.

Figure 8: The picture of test van and system set-up

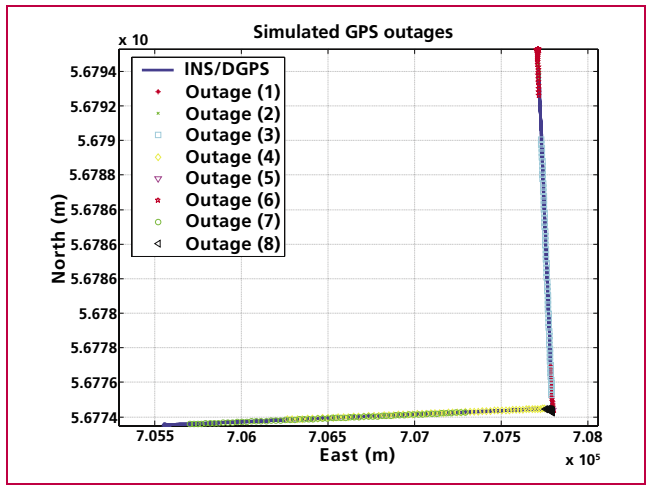

Figure 9: Location of the simulated GPS signal outages

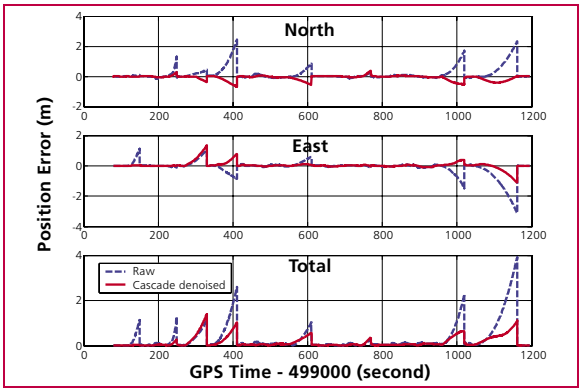

Figure 10: Positional errors (CIMU/DGPS)

The rate of improvement for individual outage periods was 75% (6/8). In addition, the magnitude of improvement ranged from 20 centimeters to 1 meter and the percentage of improvement ranged from 20% to 90%. In contrast, the remaining two GPS outage periods were not significantly degraded by the denoising operation. The magnitude of this degradation ranged from 5 centimeters to 20 centimeters and the percentage of degradation ranged from 20% to 35%.

To provide a more accurate description associated with the performance of the cascade denoising algorithm, a performance analysis index can be defined as

$$PAI(N,E) = 1 - \frac{\sum_{i=1}^{TP} \left| \delta \widehat{N}_i, \delta \widehat{E}_i \right|}{\sum_{i=1}^{TP} \left| \delta N_i, \delta E_i \right|}, TP = t * F_s, t = 450s$$

Where TP is the total number of accumulated points during all GPS outages (t is the total length of all GPS outages and Fs is the sampling rate of the IMU), and $\left| \quad \right|$ and $\left| \delta N_i, \delta E_i \right|$ are the accumulated absolute magnitude of positional errors along the North and East directions during each GPS outage period after and before applying the cascade denoising algorithm, respectively. Table 5 illustrates the PAIs for the CIMU/DGPS integrated system. As indicated in Table 5, the PAIs demonstrate the improvements after using the proposed algorithm. Therefore, despite the minor degradations, the cascade denoising algorithm was effective in improving the positioning accuracy of an INS/GPS integrated system using a navigation grade IMU in DGPS mode during several GPS signal outages. These outages were with different lengths of signal blockages and different motion dynamic variations.

For navigation grade IMU (i.e., CIMU), the long term errors of the IMU (i.e., bias, drifts) are stable and well behaved. This means that the remaining short term errors of the IMU account for most of the residual position error during GPS signal outages.

Table 4: Performance summary (CIMU/DGPS)

Blockage No.		RAW			Cascade Denoising_DGPS		
	Blockage Length(s)	MAX_ N (m)	MAX_ E (m)	RMSE Total (m)	MAX_ N (m)	MAX_ E (m)	RMSE Total (m)
1	30	0.1	1.13	0.43	0.02	0.05	0.03
2	30	1.30	0.12	0.44	0.28	0.02	0.17
3	60	0.45	1.06	0.55	0.37	1.34	0.68
4	60	2.39	0.85	1.18	0.67	0.75	0.48
5	60	0.84	0.59	0.50	0.56	0.10	0.37
6	30	0.24	0.15	0.14	0.38	0.06	0.19
7	60	1.72	1.48	1.06	0.52	0.39	0.44
8	120	2.28	3.08	1.62	1.07	0.41	0.48

Table 5: PAIs (CIMU/DGPS)

	RAW		Cascade denoising			
	$\sum\left\|\delta E\right\|$	$\sum\left\|\delta N\right\|$	$\sum\left\|\delta \widehat{E}\right\|$	$\sum\left\|\delta \widehat{N}\right\|$	PAI(E)	
INS/DGPS	7.5410E4	6.2211E4	2.9063E4	2.8992E4	75%	69%

Conclusions

This article presented a novel cascade denoising algorithm to reduce the impact of short term INS errors and improve the positioning accuracy during GPS signal blockages using several INS/DGPS integrated navigation systems. The key elements of any pre-filtering operation are to investigate the bandwidth of the true motion dynamics and remove the short term INS errors without deteriorating the true motion dynamic signal.

The results of spectrum analyses demonstrated that the bandwidth of the true motion dynamics is very low. In fact, it can be divided into two groups. The first group consists of the X-Gyro, Y-Gyro, and Z-Accelerometer with corresponding bandwidth ranges from 0 to 6 Hz. In contrast, the second group is composed of X-Accelerometer, Y-Accelerometer, and Z-Gyro corresponding to bandwidth ranges from 0 to 1Hz. In addition, the spectrum of the true motion dynamics is independent of the quality of the IMU used.

The cascade denoising algorithm developed in this article was able to overcome the limitations of existing denoising algorithms in the frequency domain. In addition, it was capable of providing superior performance in the position domain. The results demonstrated that the cascade denoising algorithm provided the most significant improvement when using a navigation grade (CIMU-=[09) DGPS integrated system; the percentage of improvement reached 58%. For a navigation grade IMU (e.g., CIMU) the long term errors (e.g., bias, drifts) were stable and well behaved, while the remaining short term errors dominated.

Acknowledgements

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Geomatics for Informed Decisions (GEOIDE) Network Centers of Excellence (NCE). Dr. Eun-Hwan Shin is acknowledged as a co-author of the AINS® toolbox used in the article for providing the INS mechanization and INS/GPS extended Kalman filter.

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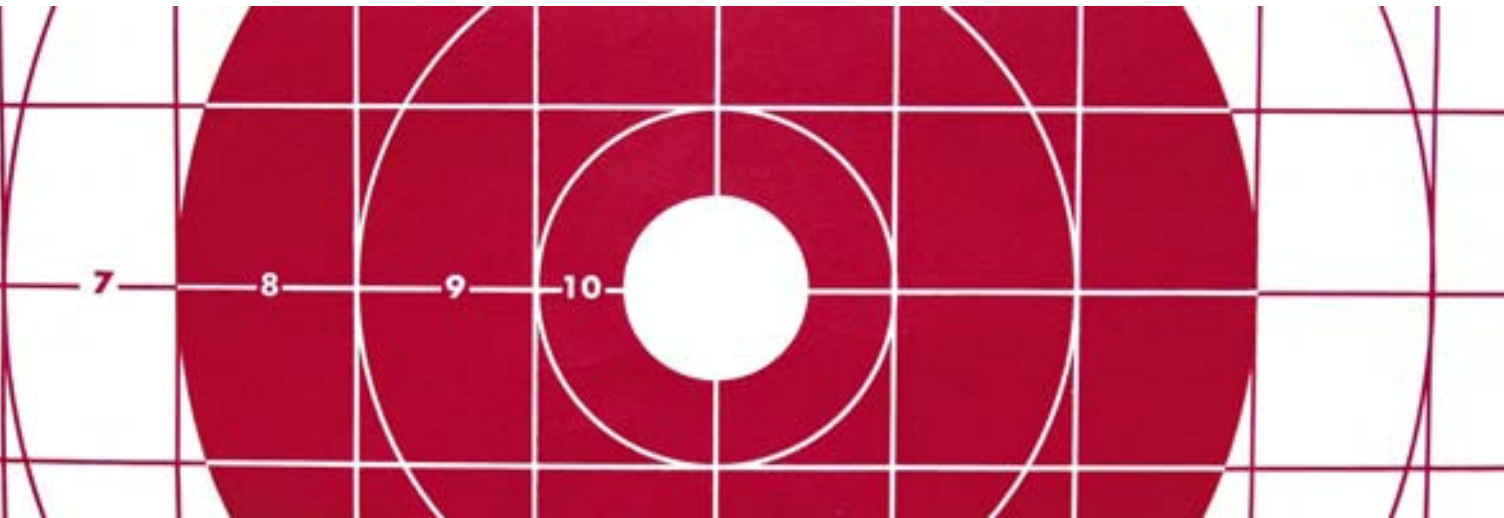

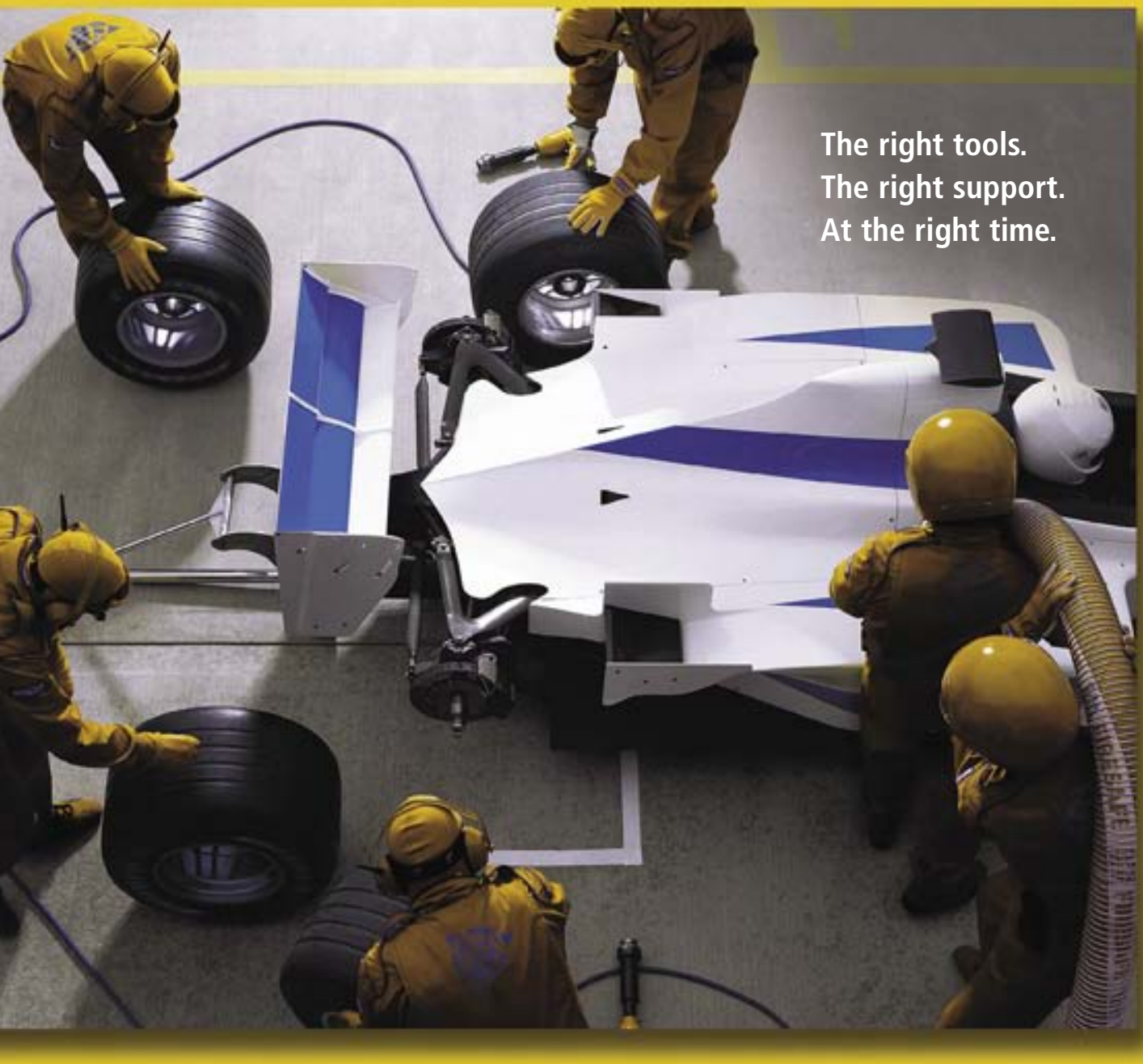

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"FSI is well equipped with state of the art systems"

Forest Survey of India celebrates 25 years. On this occation we spoke with Dr D. Pandey, Director General, FSI

What is the mandate of FSI?

The broad mandate of the Forest Survey of India is to assess and monitor the forest resources of the country to provide reliable information on various parameter of the resources such as forest cover, its quality and the changes, volume of the growing stock of wood within forest and in trees outside forests, monitor success of plantation efforts etc. for state and national level planning.

FSI is celebrating 25th years of its existence. Would you like to highlight its three major achievements?

- Reliable data on the forest cover of the country was first time estimated by the Forest Survey of India in 1987 which was hitherto not known.
- Estimation of growing stock of wood in the forests of India was first time achieved by the FSI in 1995.
- Regular reporting of the forest cover of the country on the two year cycle has created a sense of alertness among the State/UT Forest Departments. Through capacity building programme of the FSI the use of modern technology and methods of survey such as remote sensing, GIS, GPS and data processing software for inventories are establishing its roots to State/UT Forest Departments.

Please tell us the role of Geomatics in the activities of FSI?

FSI has gradually progressed to adopt the geomatics as the basic science in the assessment of the forest resources, Digital image processing of the remote sensing data for classifying the forest cover and use of GPS for ground truthing and estimation of forest plantation areas has become quite popular. Operationalyzing of geomatics fully in all the activities of FSI is the only option to enhance accuracy and speed in assessing the forest resources.

What is the status of geomatics capabilities in terms of infrastructure and trained manpower?

Adoption of any new technology is a time taking process. Geomatics infrastructure has gradually grown in the organization and presently the FSI is well equipped with state of the art systems for carrying out RS, GIS & GPS applications. Through the regular programmes of skill upgradation, the technical personnel of the organization have been trained to use the new technology. Furthermore, trained young professionals in geomatics have also been engaged in various projects being implemented by the FSI.

Do you have any programme for forest fire monitoring?

FSI is using the rapid response system developed by Maryland University of USA in collaboration with NASA where MODIS satellite data has been used for detection forest fire in India on near real time basis during forest fire session (November to May). The State Forest Departments wherever the fire spots have been detected are informed on daily basis along with geographic coordinates and approximate location in the district. On analyzing the response of the State Forest Departments more than 90% of the forest fire incidence have been found to be correct. FSI is now proposing to assess the area of forest affected due to fire by analyzing the remote sensing data of the periods immediately followed by forest fire.

What role do you see of FSI in NSDI?

Forest cover data is in demand by Forest Department of the State and UTs and also by developments agencies like Irrigation Department, PWD, Railways, Rural Development and also by NGOs. On the other hand FSI uses data from Survey of India and NRSA. FSI is a partner to NSDI process, Operationalyzing of NSDI with meta data standards and application protocol will facilitate sharing of the data both by FSI and other stake holders.

What is the status of forest in India in your perception?

With the increasing population pressure and land hunger, India's forests face a great challenge. Though at places forests get degraded but the stringent Forest Conservation Act supported the National Afforestation Programme has

helped in maintaining and improving the forest and tree cover of the country. The preacher co-active role played by the environmentalists and NGOs also needs to be appreciated.

What steps you envisage for forest conservations?

Most of the States/UTs Forest Departments are following JFM formula. It is important that JFM areas are monitored periodically to know the impact of JFM on the development of forest resources and biodiversity besides its impact on socio-economic conditions of the participating village community. In addition strengthening front line field staff who are responsible for conservation/protection is extremely important as over the years the number is going down due to sluggishness in the recruitment.

Dr. D Pandey, completed M.Sc in Statistics in 1971 from Allahabad University and joined the Indian Forest Service in 1975 and was allotted AGMUT cadre. Served in various capacities in the cadre and on central deputation as Faculty member of Forest Research Institute & Colleges. Completed Ph.D. (Forestry) from Swedish University of Agricultural sciences (Sweden) in 1996 with specialisation in 'Forest Resources Assessment'. Served as Director, Forest Survey of India during 1997 – 2000. Has several national and international publications and monographs and has been a team leader and consultant in several important forest related studies at the international level.

Galileo update

Galileo – the European Programme for Global Navigation Services for civil purposes is an initiative led by European Union. We provide regular updates to our readers on the Galileo programme.

German government makes funds available for Galileo development work

The German federal government will provide funds to the tune of 2.5 million Euros for research and development work in Rostock on the European satellite-based navigation system Galileo.

In the course of a visit to the Rostock-based technology company RST, Wolfgang Tiefensee, the Federal Minister responsible for promoting the industries of the eastern federal states that used to make up the German Democratic Republic, said that the groundwork R&D in the field of aerospace technology carried out by companies in Mecklenburg West-Pomerania was of an outstanding quality. Substantial funds would now be invested in Galileo application research, he added.

Within the context of research undertaken by RST, four transmitters will be set up in the port of Rostock capable of giving off Galileo signals. During the test phase the signals, which allow the receiver to pinpoint the position of the sender exactly, will be picked up by a ship of the ferry line Scandlines. *www.heise.de*

UK to invest another £21m in Galileo

The UK government will invest another £21 million in Galileo GNSS. Firms in the UK are already at the forefront of the £2.4 billion scheme to provide Europe with its own independent system by 2010. Trade and Industry Secretary Alistair Darling said the boost to the Galileo project was "good news for British jobs, British technology and science". Unveiling the extra cash, Mr Darling said: "The Galileo project has real potential to develop groundbreaking technology leading to more accurate in-car navigation and new systems for the emergency services to locate missing or injured people." *www.thisislondon.co.uk*

Galileo and the PRN codes hack

Professor Psiaki has said that they wanted the PRN codes of Galileo to begin testing receivers, which would work with the Galileo satellites. Psiaki was working on a receiver intended to work with both GPS and its European civil successor, which together will considerably expand today's global navigation satellite systems. He and his team hit headlines when they cracked the pseudo-random numbers (PRNs) codes of Galileo.

For testing the receivers he wanted the codes and despite requests to the Galileo folks, Psiaki couldn't get the codes the team needed to test the receiver. Psiaki and his team cracked the PRN codes and published the codes and the details of how they did it on April 1. Within a couple of days other researchers had downloaded the codes and begun using them. "Everyone knows this is not the final version," said Psiaki, "but we can test a lot of difficult and important stuff with this signal."

Despite cracking and publishing the codes, Psiaki really doesn't want anything bad to happen to Galileo as a result. "I and a lot of people want Galileo to succeed," he says. "But we don't want to be shut out." *www.theinquirer.net*

The end of 'Last Orders' in spatio-temporal representation?

A proposed new model for spatio-temporal information management

M Morad, A Adamu, S Khaddaj

Despite the rapid advances in software and hardware technologies, the development of temporal databases capable of dealing with the evolution of geographical entities remains a challenging task. The aim of this paper is to discuss a proposed model that is able to handle spatial entities over time as a continuum.

Time, Space and GIS

The modelling of spatio-temporal changes features in a wide spectrum of applications, such as socio-economic analysis, environmental impact assessment, epidemiological projections and transportation planning. Different types of data models, based on raster and vector approaches (Langran, 1993), have been used to represent changes of geographical phenomena.

Relational database models have been found to be well suited for applications where the relationships among the geographical objects are fairly fixed and well-known. By contrast, object-oriented models can outperform relational models at handling complex relationships among geographical objects, and in dealing with temporal issues (Yourdon, 1994, Wachowicz, 1999); and optimum query mechanisms can also be produced by using object-oriented approaches. The need to adopt object oriented approaches have been prompted by the fact that there are problems with relational models in the context of dynamic environments where changes can be fast, and the databases cannot rapidly accommodate the flow of information (Milne et al, 1993). An object oriented database could model the changes, encompassing a mix of geographical objects and their relationships. For example, if a road is represented as an object rather than as an entry in a database table, associations with other objects (eg, street, building, etc) linked to the road can automatically 'inherit' any changes made to the road, thereby making it easier to track later (Worboys, 1994) .

Recent research proposals have used temporal GIS and object oriented techniques to explicitly define the relationship between the events (or processes) and the objects over time. These proposals include the event-oriented model and the triad model and. The event-oriented model involves the use of object oriented techniques to identify the pattern of changes (as events) within the objects (Worboys, 1994). In order to effectively track versions of the original object, version management (Wachowicz, 1999) and identity-based methods (Hornsby and Egenhofer, 2000) have been employed. The triad model (Peuquet, 1998) is an integrated model, consisting of three independent and interrelated domains (location, feature and time) whereas in event-oriented models events are time-stamped in a sequential manner and stored progressively over time (Frank, 1994; Peuquet, 1998 and Claramunt el at, 1999).

Although the triad model constitutes an integrated approach to representing changes, it does not relate events to specific geographical phenomena; while event-oriented models are suitable for temporally stable sequential changes but are not useful for representing sudden changes (eg, earthquakes) and protracted changes (eg, annual rainfall patterns) (Peuquet, 1998). Neither model is sufficiently suitable for tracking the evolution of geographical objects where splitting, merging or transitions need to be recorded and retrieved.

A proposed new model

Object orientation has the abstraction power to represent real objects, provides the extensibility needed to create new geographical models (through 'inheritance'), and the semantic needed to construct complex objects of similar spatial and temporal

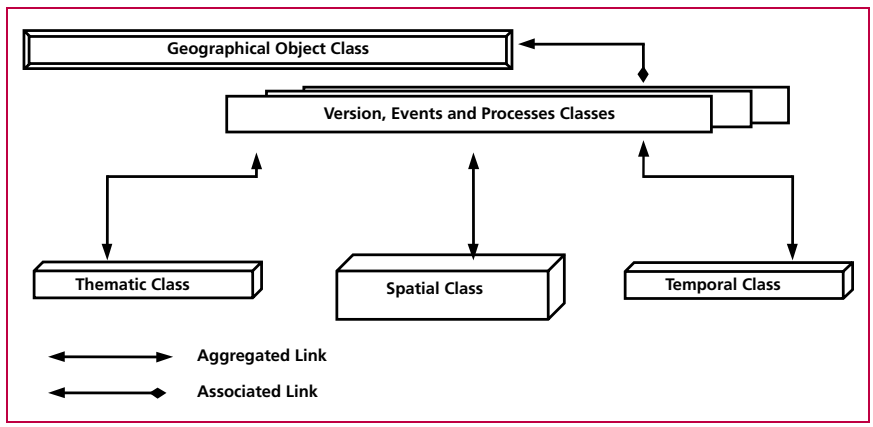

Figure 1: Composite classes of a geographical object

states (through 'polymorphism') (Yourdon, 1994). The proposed object oriented model supports both object and attributes versioning, where changes of geographical phenomena are handle by version management.

A version of an object consists of composite classes, as shown in figure 1. The aggregated composite classes include thematic class, spatial class and temporal class. The associated composite classes include events class and processes class. The spatial class deals with queries about the location of the object (eg, "where is the best museum in this city?"). The thematic class deals with queries about the features of an object (eg, "what is the speed limit of this road?"). The temporal class deals with queries about the time attributes of the object (eg, "when was hospital H built in this locality?").

The thematic, spatial and temporal classed are linked to a composite class structure recording versions, events and processes. An event class deals with the cause of the changes of the geographical object (eg, "the event which marked reducing the speed limit on road R"). A process class handles the effect of changes of the object (eg, "how much rainfall will be expected to cause a flood?").

Figure 2 explains the workings of the version class. A geographical object is represented as a generic object, and the first object and any subsequent changes can be represented as versions. Each version of the object records the changes (involving an attribute or behaviour) signalled by the aggregated spatial, thematic and temporal classes and the associated events and processes classes. Subsequent changes of the attributes of a geographical object will dynamically generate related attributes and temporal links updated by the corresponding versions, an effective facility proposed originally in a research paper by Owen (1993). The relationships between the generic object and versions of that object are represented by a temporal version management approach, as discussed by Dadam et al (1984) and Wachowicz (1999). This method of version management uses temporal operators (eg, during, after, before etc) to handle gradual and sudden changes, as defined by Allen (1984). To avoid the use of large storage space, only the generic object (or subsequently the current object) holds the complete attributes and behaviour of the object while the other versions record only the changes in their attributes and behaviour.

The temporal relationships between the current object and versions are given by:

$Versions(x) = (\Delta x\ (n,n-1),\ \Delta\ x\ (n-1,n-2),\ldots,\ \Delta\ x\ (n_0+1,\ n_0),\ CVx(n_0))$ (1)

Where $CVx(n_0)$ is the complete version of object x whiles n_0 indicates the generic version, which holds the complete attributes and behaviour. $\Delta\ x\ (k, k')$ represents the difference between the current version (k) and the previous version (k') of object x. As shown in equation (1) access to the current version n requires $n-1$ iterations, which means evaluating delta version $\Delta x\ (n_0+1,\ n_0)$ followed by delta version $\Delta x\ (n_0+2,\ n_0+1)$, then the next version up to delta version $\Delta x\ (n,\ n-1)$. This forward versioning strategy provides faster access to the oldest version.

A shown in equation (2), previous versions can be evaluated from current versions, and this strategy is known as backward versioning. The method in equation (2) provides a quicker access to the current versions.

$Versions(x)=(CVx(n),\Delta x(n,n-1),\Delta x(n-1,n-2),\ldots,\Delta x(n_0+1,\ n_0))$ (2)

When a geographical object changes, the generated dynamic attribute locates the versions and creates temporal links between the previous version and the new versions. Similar equations, which can be used for splitting and merging of objects, are provided by Dadam et al (1984).

A version of an object is induced by changes (attribute or behaviour) of the spatial, thematic and temporal classes. Subsequent attributes and behaviour of the classes are automatically updated to the respective class. Each attribute or behaviour change is contained in a version, linked bi-directionally to the respective spatial, thematic and temporal classes.

Model implantation and evaluation

The model was implemented using an object oriented database, Objectivity, and the object oriented programming environment Visual C++. The relationships between the classes are established in the application schema file using the object reference class function, ooRef. For example, when the first line of code below is inserted in the version class and the second in the spatial class, the relationships between the version class and the spatial class is created.

1) *ooRef(Spatial) current_spatdata;*
2) *ooRef(GObject) current_SpatObject;*

Objectivity/DB has the capabilities to represent the versioning approaches (ie, linear, splitting and merging) demonstrated in the OOM. Linear changes are represented by linear versioning method using the *setVersStatus(oocLinearVers)* function. Changes involving splitting are represented by branching versioning technique using the *setVersStatus(oocBranchingVers)* function. Geographical phenomena involving merging are represented

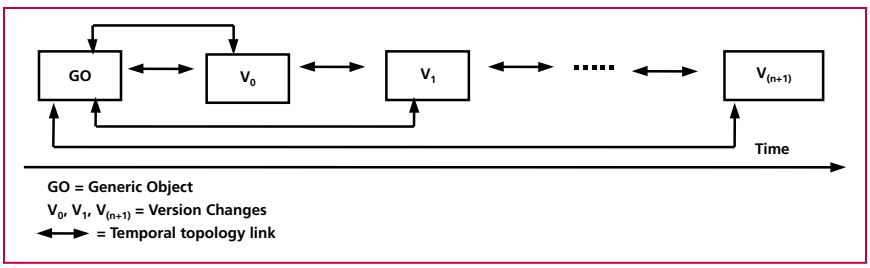

Figure 2: Relationship between the versions and generic object

by the merging versioning approach using the *add_derivative* function. If the properties of the merged object are similar to the previous objects, the *add_derivedFrom* function is used. Versioning is established by invoking the *version(copy)* and *version(move)* function in the application DDL (Data Definition Language) schema file. The *version(move)* function allows the attributes and behaviour of the previous version to be moved to the current version and the *version(copy)* function enables the copying of the properties of previous version to the current version.

Persistence objects are identified using the object identifier (OID) which is unique within a federated database. Objectivity/DB uses the object handle class, *Handle*, to access persistent objects automatically by the DDL process for every persistence class found in the schema header. The persistent objects of the version class was represented by *GObjectH*, the spatial class by *SpatH*, the temporal class by *TempH*, the thematic class by *ThemH*, the process class by *ProcessH* and the event class by *EventH*. For example, the persistent objects of the version class and the spatial class are generated using the method below:
Handle (Spatial) SpatH; Handle (GObject) GObjectH;

Aggregated relationships between the version class and the spatial class, the thematic class and the temporal class are established in the application source code using the code below:

GObject::GObject():
current_spatdata(newSpatial()),
current_tempdata(newTemporal()),
current_themdata(new Thematic());

A dynamic function handles the temporal relationships between versions, events and processes. The code below generates the relationships between the versions, events and processes. Each process is linked to the event through the corresponding version.
EventH=new(GObjectH)
Event(TempEvent);
ProcessH=new(GObjectH);

A test of the functionality of the model was conducted which involved the tracking of geographical objects that experienced versioned events triggering by spatial and thematic attribute changes. Comparing the historical map of Canbury Ward in 1913 (figures 3-5) and that of 1933, there was an expansion on the Upper Ham Road in 1933 to ease traffic congestion in the area. Figure 4 shows a sample dialog box that was used to update the spatial attributes of the Upper Ham Road. The attribute changes (ie, spatial) were updated to the new versions of the geographical object. The spatial changes represent the Y (northing) and the X (easting) coordinates of the geographical objects. The spatial attributes were updated on the map by retrieving values from the database as shown in figure 5. The updated spatial attributes shown represents the northing and easting coordinates of the new versions of the geographical object Upper Ham Road.

Figure 3: Changing the attributes of the old Upper Ham Road

Figure 4: Dialog box for updating spatial attributes of a version

Conclusion

The proposed system constitutes good temporal representation, because the temporal attributes and behaviour of the versions are independent, but retain dynamic relationships which enable the tracking of individual thematic, spatial or temporal events and processes as distinct (rather than hierarchically indexed or consolidated) versions. Moreover, the temporal attributes in the proposed model include temporal operators to promote the continuous analysis of patterns of change. The system also works well with both gradual and sudden changes because the attributes of events have temporal operators, and versions have built-in relationships between them. The GIS system proposed by the authors eliminates the need for large data storage capacities by recording only the changes in the spatial, temporal, thematic, event and process classes. The results have also indicated that continuous tracking of the patterns of change of geographical phenomenon can be achieved effectively. The development of an improved graphical user interface together with interfacing with some existing geographical information systems will be tackled in future work.

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Figure 5: Historical map of Canbury Ward in 1933 showing the new spatial attributes

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"We encourage fishermen to use GPS"

Says Dr Shailesh Nayak, Director, Indian National Centre for Ocean Information Services while sharing his views on mandate, activities and future plans of INCOIS

What is the Mandate of INCOIS?

The mandate of Indian National Centre for Ocean Information Services (INCOIS) is to conduct research in the field of Ocean Observation (in-situ and satellite), generation of data products and to provide information and advisory services related to living resources, sea state and early warning for coastal and ocean hazards. This information is disseminated for the societal, governmental and research needs.

What are the main activities of INCOIS?

The current activities of INCOIS are to provide

i. Potential Fishing Zone Advisories thrice in a week
ii. Ocean State Forecast
iii. Early Warning for Tsunamis and Storm Surges
iv. Ocean Information Bank and web-based dissemination
v. To support ocean modeling and data assimilation research
vi. Satellite oceanography research
vii. Ocean Observation.

What about Fishing Zone Advisories?

The Fishing Zone Advisories is one of the most important activities of the centre. You probably know that about 7 million people living along the Indian coastline and are dependent on fishing for their livelihood. The reliable and timely forecast on the potential zones of fish aggregation, based on satellite data provided by ISRO, helps fisherman to reduce time and effort spent in searching the fishing grounds. This service has helped to improve their socio-economic status. The searching time for the fishing grounds has been reduced up to 30% to 70%.

Are they used by fishing community?

Certainly. Our estimate is that about 20,000 fishermen have been actively using these advisories.

How do you communicate your information to them?

The information is communicated through Electronic Display Boards located at 22 major fishing harbours, 200 Fax and Telephone nodes 70 email users and print media as well as through INCOIS website. We provide these advisories in local languages and in local measurements, units for their effective use. The research institutions and fishing associations all make Web GIS.

What is the role of geomatics?

Remote Sensing is playing very crucial role in Ocean Observations. We derive Chlorophyll maps based on our own Oceansat-1 OCM data, Sea Surface Temperature for PFZ Advisories. Sea Surface height, sea surface wind from international missions are also used for Ocean State Forecast and Ocean Modeling activities. In fact, we receive directly NOAA, MODIS data at INCOIS. The large amount of data in organized in GIS and information systems are designed for their effective use.

Any role of GPS?

GPS has very important role to play. We are encouraging fishermen to use GPS for reaching fish aggregate sites based on PFZ Advisories.

INCOIS role in ocean related disasters?

INCOIS is the lead agency to issue early warning for tsunamis and storm surges. We have already set up a 24x7 Tsunami Warning Centre at INCOIS. This system encompasses:

- Near-real time determination of earthquake parameters in two known tsunamigenic zones using network of seismic stations.
- Establishing a comprehensive real time ocean observational network comprising Bottom Pressure Recorders, Tide Gauges and Coastal Radars
- Numerical models for tsunami and storm surges
- Generating coastal inundation and vulnerability maps
- Capacity building and training.

Do you tie up with international organizations?

Yes. We have very intense interaction with many international organizations. They are

- Intergovernmental Oceanographic Commission (IOC), UNESCO, Paris
- Indian Ocean Global Ocean Observing System (IO-GOOS) of IOC
- ARGO Profiling floats Regional Data Centre
- Partnership for observation of Global Ocean (POGO)

- International Ocean Colour Coordinating Group (IOCCG)

Any plan to share the information with NSDI?

The information generated by INCOIS is available on its website. We share our information with everybody. As far as NSDI is concerned,, issues related to framework, format, standards, etc. would need to be worked out.

What are the future Plans?

Our future plans include development of coastal ocean state forecasting system for providing daily sea state bulletins, 3-5 days short-term forecast, monthly/medium range forecast and decadal long-term forecast. Apart from this, we would also like to initiate new services such as monitoring of toxic blooms, assessment of fish stock, primary production, fluvial fluxes, coral and mangrove ecosystem health, etc.

Dr Shailesh Nayak has been recently appointed as a Director, Indian National Centre for Ocean Information Services (INCOIS), an autonomous institution under the Ministry of Earth Sciences, Hyderabad. At INCOIS, he has been providing leadership for realizing the project on "Establishment of National Early Warning System for Tsunami and Storm Surges in the Indian Ocean and conceptualization and development of Marine GIS. He has obtained PhD degree in Geology from the M.S University of Baroda in 1980. Earlier, he worked as a Group Director, Marine and Water Resources, at the Space Applications Centre (ISRO), Ahmedabad from 1978 to 2006. He has been member of many national committees related to coastal protection, mangrove and coral reef, coastal zone management formulated by the Ministry of Water Resources and Ministry of Environment and Forests, Govt. of India, respectively. He is member of the Research Advisory Committee of the Wadia Institute of Himalayan Geology, Dehradun and Centre for Earth Science Studies, Thiruvananthapuram. He was awarded the Indian National Remote Sensing Award for the year 1994 by the Indian Society of Remote Sensing, Dehradun. He is recognized as Ph. D. Guide by six universities. He was Member of the editorial board of the Indian Journal of Marine Science and currently one of the editors of Geospatial Today.

He is President, ISPRS, Technical Commission (TC) IV on 'Geo-databases and Digital Mapping' for the term 2004-08. He has represented ISRO at the International Ocean Colour Coordinating Group and International Global Observation Strategy-Coastal theme. He has published about 70 papers in International and National journals and atlases.

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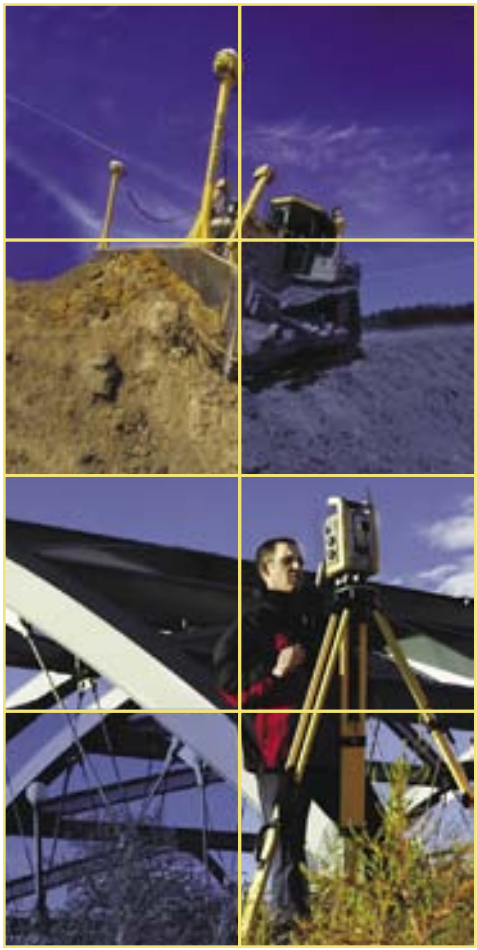

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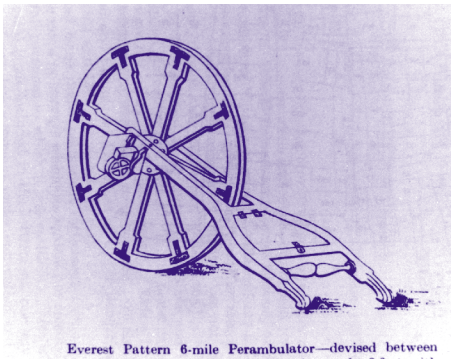
Everest in England 1825-1830

For anyone serving in India during the 19th and early 20th century life was obviously very fraught with sickness problems. Essentially if the sickness was not too bad you were sent to South Africa to recuperate but if it was serious then it was likely that you could obtain home sick leave. This is what happened to Everest who was so affected by fevers and the after effects that he was away from India for five years. By any criteria that is a long period for recuperation and in fact after the first few years his masters insisted that he be back in India within the five years.

As with when he was in South Africa he was not idle. Whenever his health allowed he was working on activities related to the Great Trigonometrical Survey. Within a year of leaving India he was nominated to become a Fellow of the Royal Society. This was, and still is, one of the most prestigious memberships that a scientist could achieve.

Interestingly at the time of the award Everest had achieved little compared with that which was to come later.

His time was particularly spent in two areas – the compilation of a Report on all that had so far been achieved on the Great Survey and secondly on the design and purchase of new instrumentation [2]. This latter allowed him to take back to India on his return equipment that was at the cutting edge of technology at that time.



Everest Pattern 6-mile Perambulator—devised between 1832 and 1836—had a wheel of diameter just under 3 feet, with differential dials reading to miles and decimals of miles.

His Report [1] published in 1830 was a major scientific work and to both compile it and get the printed copies available by the time of his return was a massive achievement. From the work already done on the survey he was able to make comparisons between three sections of the India arc with nine other arcs to determine values of his own for the earth parameters. These became known as Everest's First, or 1830, Figure of the Earth.

To ensure that he was aware of all the latest instrumentation he spent much of 1828 travelling around Europe including Rome, Venice and Vienna and almost certainly taking the opportunities to visit all the instrument makers. As a capable mechanical engineer he would have been seeking ideas and these he took back to English makers where he had a small theodolite made to his own design. This was unusual in having just two part circles rather than a whole one in the vertical plane. As the instrument was aimed at use in revenue survey work his attitude was that only relatively low elevation angles were required so why have a full circle.

In 1829 Everest went to Ireland to meet Col. Thomas Colby who in 1827 had been involved in the measurement of the Lough Foyle baseline of some 41 000 ft length. (12.5 km). In addition to showing a keen interest in the theodolites of various sizes he was particularly keen to know all about the bar equipment that Colby had used for the measurement. This was what came to be known as the Colby compensating bar. There were six bars each of about 10 feet in length in a set and Everest managed to obtain a set. To test them out before returning to India he arranged to use Lords Cricket Ground in London and to practice over a line of 567 feet length where his out and back measures agreed to 3/40 inch (1:90 700). Each unit consisted of a bar of brass and another of iron so arranged and joined together to compensate for

any expansion due to temperature changes. This was ingeniously achieved by use of the fact that the two coefficients of expansion differed in the ratio of 2 to 3. The whole was placed on rollers in a long wooden box. [2]

Consider the time it took Everest on the first baseline he measured using the equipment – i.e. from 5 November 1831 to 28 January 1832 for 33960 ft - with the time required today to measure a similar line to the same accuracy. For that length the 10 ft bars would have been set on tripods, levelled up and readings taken almost 3400 times. On 8 June 1830 Everest sailed for India with a wide range of new instrumentation and would have had an even wider range if there had been any person on his staff capable of using pendulum equipment.

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Cartography as a tool in study of dredging

The story of dredging is best understood by a sequential study of maps over the last two to three centuries accompanied by cross sectional profiles

Sachin S Pendse

Mumbai acquired its port importance only with the advent of the Portuguese in 1508. Francis Almeida sailed into this harbour and called it as Bom Bahia or the Good Bay. The British corrupted the Portuguese name "Bom Baia" to "Bombay". The Kolis used to call the islands "Mumba" after Mumbadevi.

It was the British who developed it into a centre of commerce to rival any other centres in the country then. The British embarked upon large-scale reclamations and engineering works to consolidate the seven islands. In 1803 Bombay was connected with Salsette by a causeway at Sion. A causeway now called Colaba Causeway joined the island of Colaba to Bombay in 1838 and the Causeway connecting Mahim and Bandra was completed in 1845. This gave access to the rich hinterland of the Deccan providing further impetus for the growth of then Bombay.

The Mumbai port was expanding and the need for extended port facilities led to formation of the Mumbai Port Trust (MPT) created in 1873.The MPT was responsible for reclamations and constructions in the harbour area of Mumbai. Sassoon docks were commissioned in 1875.

In 1880 the Trust inaugurated the Princes' Docks along with warehouses and storage sheds; in 1888 it completed the Victoria Docks, and two years later the Merewether Dry Docks. Towards the beginning of the 20th century, the MPT started on an immense project of reclamations all along the harbour front from Sewri to Apollo Bunder. With these works, the Trust eventually created 1880 acres of land. The Princes Dock was built in the year 1885 and the Victoria Dock and the Mereweather Dry Docks in 1891. Alexandra Dock was completed in 1914. The Port Trust Railway from Ballard Pier to Wadala was opened in 1915. Along this railway were built grain and fuel oil depots.

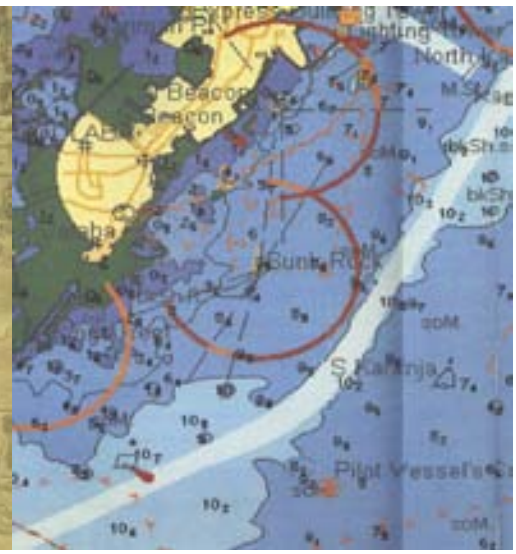
The problem faced by port activities in the Harbour Bay were mainly due to rapidly declining depths of the harbour making navigation difficult. This was further aggravated by the increasing traffic and that too with higher capacities. The harbour required greater depths up to 12 meters plus in the navigation channel. The existing channel prior to the construction was inadequate for accommodating the larger ships.

The Harbour

The deep and safe Mumbai harbour is a creation of three main factors, The Thane creek, which branches from the west flowing Ulhas creek southwards off Thane along the eastern shores of salsette Island towards the Harbour Bay, acting more like a flush. On the eastern side of the harbour entrance lays the Dharamtar creek of the river Amba and Panvel and Patalganga creek joins the harbour east of Trombay and north of Nhava-Sheva. The port hardly had any problems of siltation till late fifties.

Before reclamation the harbour depth was maintained due to natural topography, which allowed free access to the sea at various points. Excess silt was carried away to the sea. The story of dredging is best understood by a sequential study of maps over the last two to three centuries accompanied by

Marine Surveys 1855-1947

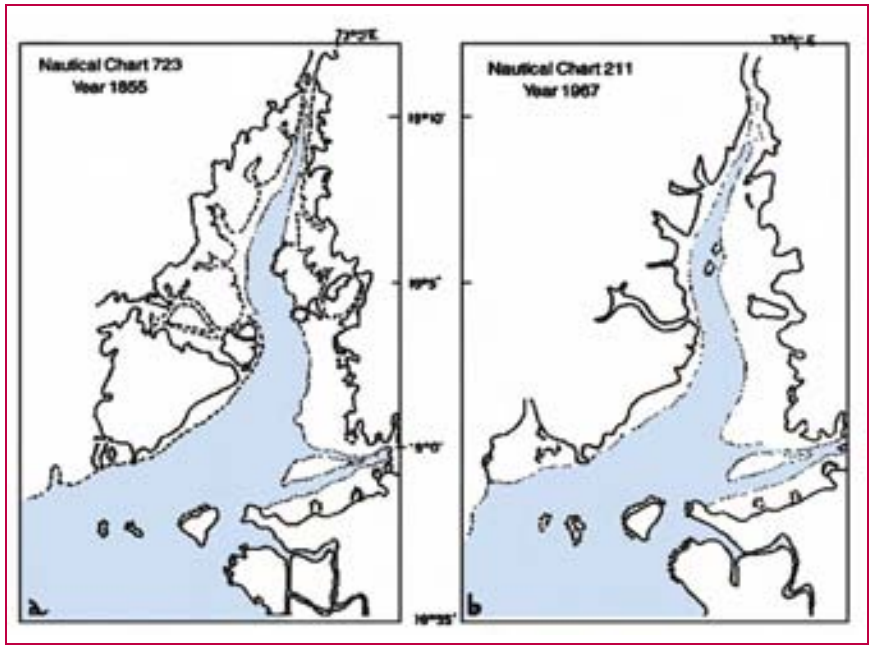


Part of Electronic Navigation Chart 2005

cross sectional profiles. Cartography indeed becomes a powerful tool in understanding the problems and the temporal changes and shifts. Any solution for the future will have to be examined from a naval engineering point of view with the aid of maps of underwater soundings depths and the alignment of navigation channels. The present paper looks into this aspect, with help of maps and charts.

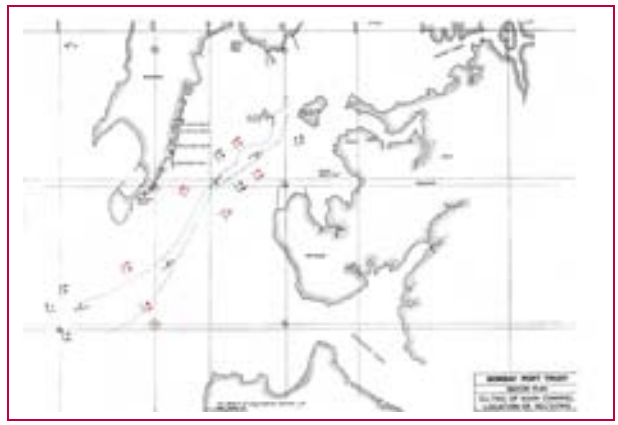
The Problem

The growing importance of the city as an economic hub resulted in increase in port activities. The Harbour Bay, which was initially a mud basin with multiple entries of the tidal rush through inland lagoons between the islands gradually, underwent transformation. Bombay became a major international harbour with the advent of steam navigation in the early 19th century followed by construction of docks in the second half. Technologically steam ships brought in a new era of larger vessels with a carrying capacity exceeding 50,000 tonnes and later reaching to 3 to 4 lakh tonnes. This required deeper drafts than that prevailing in the mid 19th century. The Harbour Bay was a small cove to south of the Castle where Bombay docks were built in 1848. Later the construction of docks along the eastern front consolidated the island city. The inflow of the tide from the west was totally blocked. The Harbour Bay became much wider and enlarged between the island city and the mainland shores. The inflow of rainwater floods in the Harbour Bay was both from north through the Thane creek and from the east through the large number of tidal inlets. The centripetal drainage of Dharamtar creek and Kundalika estuary further south, unfortunately, brought increasingly muddy and silty waters into the Harbour Bay making the bay shallower. Therefore in-spite of an enlarged bay it was subject to a rapid rate of siltation and sedimentation. The Thane creek ever since the railways were built in 60's of 19th century was slowly silting since the Ulhas floods were blocked at silte depth level by railway and road bridges. During the 20th century the creek was subject to rapid decay both in width and depth. Thanks to land reclamations particularly along the eastern seaboard prominently in the second half of the twentieth century began to push into the Thane creek was progressively narrowing down the creek. Destruction of extensive mangroves on both sides of the creek added to the problems. These changes in the morphology of Thane creek are evident from the two nautical charts that of 1855 and 1967.



Further the rise of New Bombay along with its residential and industrial areas along the Trans Thane creek and large-scale reclamations along Mulund, Bhandup, Vikhroli and Ghatkopar, caused further destruction, Caught in this dual sided onslaught the creek is dying rapidly. The growth pattern suggests the lack of vision of town planners and builders regarding its impacts on the creek and the sea. The changes in the tidal flows, siltation and currents were ignored. Reclamations for making of Sion causeway and later along Sewree, Wadala stretch, and then recently the express way led to destruction of extensive mangrove forests along the creek further reducing the natural silt traps.

The major impact of this has been that the natural flushing of the silt in the harbour is getting reduced thereby making the Harbour Bay shallower. The reclamations altered the flows and currents resulting in increased siltation drastically. Now the natural harbour needs to be continuously dredged. Presently some of the docks and breakwaters have been rendered difficult to access. Due to siltation a heavy price is paid for faulty designing and ignoring natural the forces of the sea.1 The creek decay has literally choked the north end of the Harbour Bay. All this meant that the Harbour Bay had to be dredged constantly so as to maintain a navigable channel with the entries to the docks at the desired



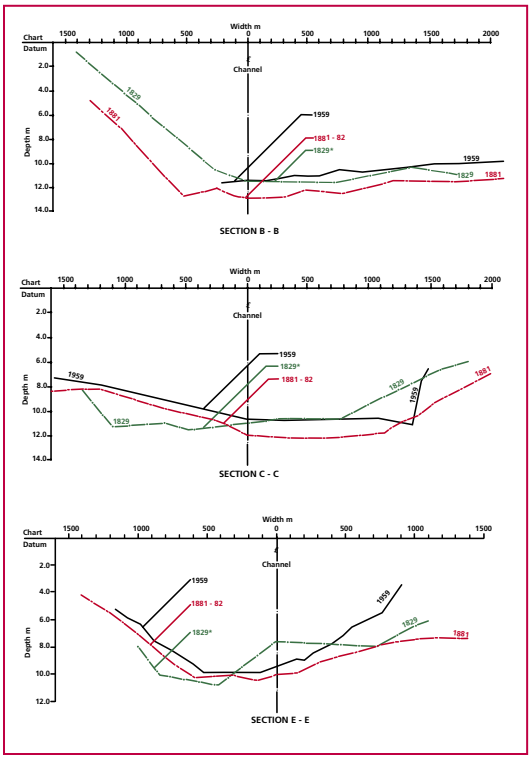
Main Channel: Location of Cross Sections

depths. Lack of vision in construction of the docks opening to the north has contributed to the tidal flush hitting the mainland shore turning south in a ebb along the docks and contributing to siltation of docks themselves which acted as silt traps. While it was being realized that dredging was inevitable its intensity has however to be gauged and constantly monitored. The depth of the Harbour Bay even in middle stretches did not exceed 7 to 8 metres in earlier stages. 20th century Navigation demanded approach channels that are at least 12 metres plus deep to reach the individual docks. Dredging requirement in Mumbai harbour is steadily increasing and at present is about 10 million M3 per year2. The silt mainly accumulates around the corners and barriers. The main channel needs to be dredged deeper every fourth year as the Thane creek flushes the Harbour Bay. as seen earlier.

With increasing congestion of traffic in the last 30 to 40 years in the Mumbai harbour the Centre took decision to develop an independent container port with its own infrastructure facilities. The obvious purpose was to segregate the port traffic of Mumbai docks from the container traffic now converging at the Nhava Sheva renamed JNPT or the Jawaharlal Nehru Port Trust. In retrospect it appears that the location of this container terminal port is possibly a two fold blunder for two reasons. Firstly international container vessels being much larger in size than the shipping vessels hitherto visiting Mumbai there is dire need for much greater draft depth of least 15 to 16 metres, since the navigation channel through which traffic flows from the Harbour Bay entrance to JNPT container port is merely an extension of already existing navigation channel leading to Mumbai docks. While apparently the pressure on docks traffic is reduced theoretically the impact on the navigation channel has tremendously enhanced and the congestion is nowhere showing symptoms of reduction. New problems are arising and dredging the channel to further depth of 5 metres is posing a tremendous challenge that may even boomerang.

There is yet another problem that dredging creates, While dredging is becoming a necessity the removal and dumping of the dredged spoil is even more exacting. In earlier stages during the second half of the 20th century the spoil was being dumped in the Karanja- Uran base that has fast filled in. The nature of tidal circulation in Harbour Bay partly shifts the dumped material into the Mumbai docks that have got to be dredged continuously to the relevant depths. Also simultaneously a large volume of spoil is taken southwards by littoral drift circulation that in early days used to choke the Dharamtar creek, but now is being carried further south of Revas, Kihim, Chaul and Alibag shores incidentally resulting in formation of new beaches. Any further dredging as visualised to help the container port would demand a fresh dumping ground much further south along the Konkan coast or at greater depths either way posing serious navigation hazards. Already few vessels have wrecked on the approach to harbour due to siltation. A third aspect is that of Thane creek decay and any further siltation would lead to a direct impinging effect on the JNPT port to north of Elephanta. The dilemma for the port authorities is pretty serious. to dredge or not to dredge.

Perhaps a better solution would be to take a bold decision to shift the container port to a much further destination. The political will required will demand an enlightened government.



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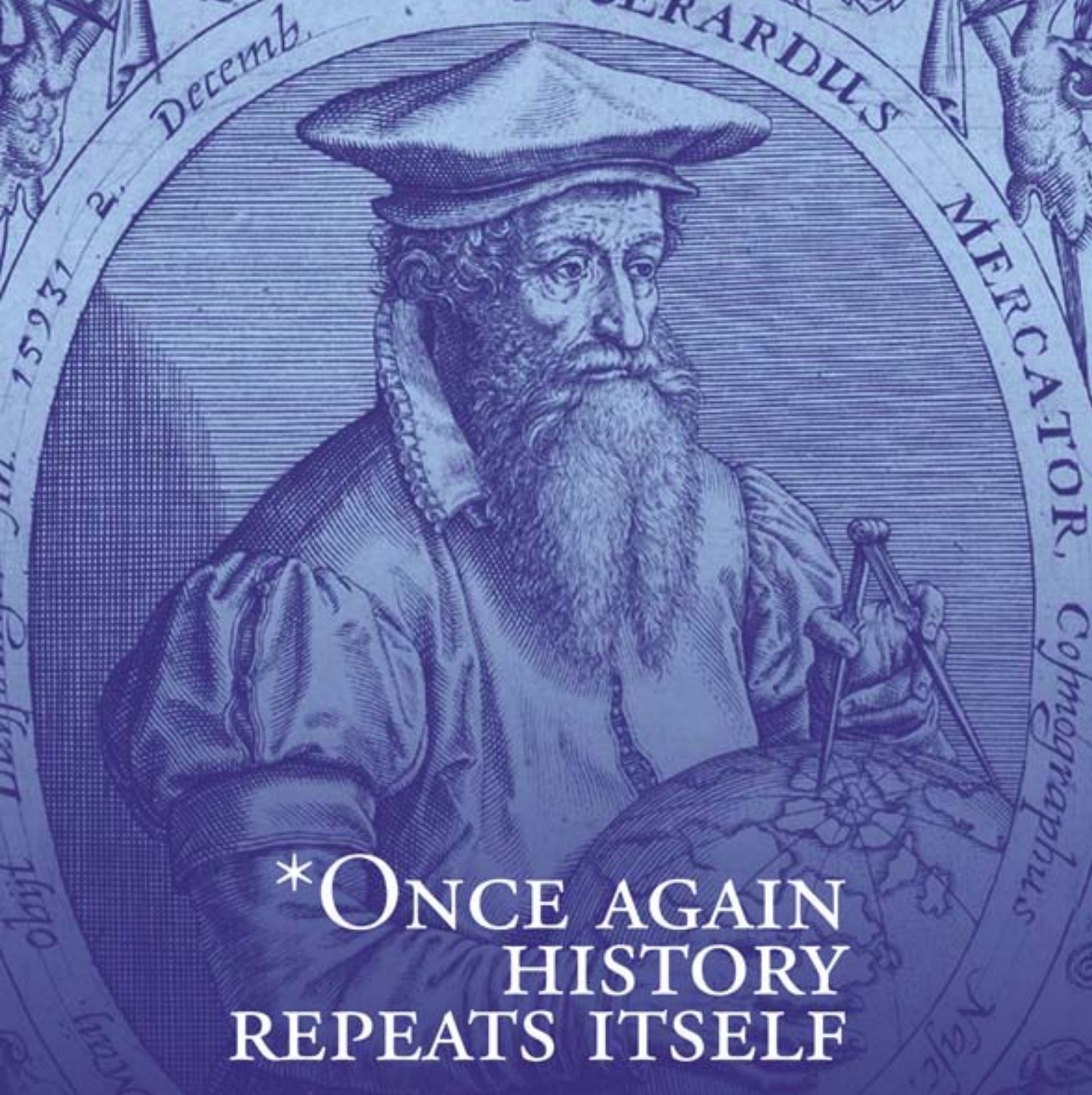

*Once again history repeats itself

In Leuven, Flanders, we have a pedigree of almost 500 years of navigational geniuses. These days it's Septentrio that pioneers precise positioning & timing developments. It is ***our*** Galileo receiver that is chosen by ESA to validate the first-ever Galileo signals. And it is ***our*** PolaRx GPS product family that measured the peak of the Aconcagua.

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Versatile OEM Receivers for Demanding Applications

ESRI's user conference highlights new developments in GIS

A report on the 26th ESRI user conference, 7 - 11 August, San Diego, USA.

JIM BAUMANN

ESRI President Jack Dangermond set the tone for the company's 26th annual international user conference by announcing in his introductory address that, "This week is all about GIS, geography, and sharing our knowledge. You are working on problems that are international in scope including population growth, global warming, urbanization, pollution, public safety, and many other critical issues."

The imminent release of ArcGIS 9.2 attracted much interest among the 14,000 plus group of conference attendees. These enhanced features include improved tools and interfaces, support for sophisticated cartographic design, advanced modeling tools for image processing and analysis, and enhanced CAD support. Another new feature is geodatabase archiving, which allows the recording and display of changes over time that can be used with the new animation tools to create, play back, and export animations and animated graphics.

To demonstrate this new and powerful feature, information regarding the historical increase of children afflicted with asthma was displayed. Another dataset showed historical data about air quality in the areas where these children resided, and yet another dataset showed addresses of afflicted children in proximity to freeways. Bringing the datasets together in GIS to produce an animated historical map that showed changes in asthma cases, air quality, and freeway exhaust made correlations obvious.

Bob Kerrey, President of The New School and former U.S. Senator, delivered the keynote address. While in government, Kerrey spent some time examining the relationship between geography and public policy, which gave him insight into the effects of globalization with the relocation of people from agricultural communities to urban areas.

One of the many highlights of the conference was the awards ceremony honoring exemplary achievement in GIS application and implementation. The ESRI Presidential Award is one of the company's most distinctive honors and is presented annually to an organization that has achieved a level of success that significantly expands its application of GIS technology. ESRI President Jack Dangermond personally selects the organization that receives the award. This year, the award was presented to The Ordnance Survey of Great Britain. Accepting the award on behalf of the organization was Dr. Vanessa Lawrence, the Ordnance Survey's Director General and CEO. Observes Dangermond,

"Great Britain's Ordnance Survey has developed one of the largest, most successful GIS's I have seen. The organization has transformed itself from providing a traditional mapping service to that of a complete geospatial organization to meet the growing needs for GIS services in the United Kingdom." Other awards included the ESRI Lifetime Achievement Award, which was presented to Larry Smarr, Director, California Institute of Telecommunications and Information Technology, University of California, San Diego. In presenting the award, Dangermond described Smarr as the “leader of the supercomputer movement."

Distinguished Service in GIS Awards were presented to Dr. N. Vijayaditya, Director General and Dr. Vandana Sharma, Sr. Technical Director, both of the National Informatics Centre of India, and Lt. General James R. Clapper, Jr., U.S. Air Force (Ret.); Former Director National Geospatial-Intelligence Agency (NGA).

Other conference highlights included product updates and discussions by senior ESRI product managers, one-on-one consultations with GIS software experts, more than 300 technical workshops on ESRI software, more than 1,000 professional user paper presentations, an exhibit hall showcasing hundreds of GIS solutions, GIS user achievement awards, special interest group meetings, and regional user group meetings.

Concurrent ESRI user conference events included the Survey and GIS Summit and the Education User Conference (EdUC), as well as more than 40 pre-conference seminars and

special training sessions. Dangermond indicated that, "The theme of this year's conference 'Geography and GIS–Communicating Our World' reflects both the maturation of the industry and its expanding impact on society in general.

"With the recent proliferation of GIS Web-based services, combined with new server technology, and intuitive, easy to use Web clients, GIS technology is poised for greatly expanded use by many who may not even be aware of the underlying technology they are using. They have problems to solve and research to perform and Web-based GIS presents the best medium to provide the necessary solutions or analyze results.

"In this context, GIS technology can be thought of as a new medium for communication, not unlike newspapers, radio, television, and the Web. Today, this medium is being used to help people better understand situations and events and work collaboratively to determine the best solutions. GIS can even assist in forecasting the future by means of predictive modeling.

"Over time, GIS will become more widely used in collecting, categorizing, refining and communicating our collective human knowledge and experience. This will provide many benefits to our global society by helping us better understand and direct our shared future."

Dangermond concluded his remarks by quoting the American cultural anthropologist, Margaret Mead, "Never doubt that a small group of thoughtful, committed citizens can change the world... indeed, it's the only thing that ever has."

Glonass full deployment by 2010

Russia's 24-satellite navigational and GPS, Glonass, will be fully deployed by 2010 as per Russia's Defense Ministry. The ministry's press office said the development and use of Glonass was discussed in Moscow at a meeting between Deputy Prime Minister and Defense Minister Sergei Ivanov and members of a government military commission. Also discussed were ways to improve the competitiveness of navigational services, the mass production of navigational equipment for consumers, as well as legal issues. *http://en.rian.ru*

Serbia builds GPS infrastructure network

Trimble has announced that it has supplied GPS reference stations and VRS (Virtual Reference Station) software to establish one of the first Eastern Europe nationwide VRS infrastructure networks. Located in Serbia, the multi-purpose network provides a geospatial infrastructure for surveying, engineering and GIS professionals. The Serbian VRS network or AGROS (Active Geodetic Reference Network of Serbia) is operated by the Serbian Geodetic Authority (RGZ), the national organization for cadastre in Serbia and the network was established in co-operation with Faculty of Technical Sciences in Novi Sad (FTN). Built with 32 Trimble 5700 Continuously Operating Reference System (CORS), Trimble GPSNet and RTKNet software, the network is available to all geospatial professionals. *www.trimble.com*

Tsunami's impact on Earth's gravity

Scientists funded by NASA, the US National Science Foundation and the Ohio Supercomputer Centre have used satellite data from NASA's two gravity recovery and climate experiment (GRACE) satellites for the first time to detect changes in the Earth's surface caused by a massive earthquake. The research paints a clearer picture of how the Earth changed after the December 2004 Sumatra-Andaman earthquake, the 9.1-magnitude temblor that set off a devastating tsunami across the Indian Ocean in December 2004 disrupted the earth enough to change gravity and to deflect satellites passing hundreds of miles above. "The earthquake changed the gravity in that part of the world in two ways that we were able to detect," said Shin-Chan Han, an Ohio State research scientist. First, he said, the quake triggered the massive uplift of the seafloor, changing the geometry of the region and altering previous GPS satellite measurements from the area. Second, the density of the rock under the seafloor was changed after the slippage, and an increase or decrease in density produces a detectable gravity change, Han said. *www.zeenews.com*

Landing technolgy with GPS

Thomas Cook is the first UK airline to gain CAA approval to use cutting edge GPS-based RNAV (Required Navigation) technology in landing approaches. RNAV likely to be used by all civil aircraft in the future utilises onboard computers and software linked to Flight Guidance systems to produce remarkable new benefits on approach. A three-dimensional approach is generated which mimics a conventional instrument landing, normally associated with a major airfield. The system supplies the flight deck with accurate glide slope indications, even at destinations, which do not have precision approach aids. *www.breakingtravelnews.com*

Tracking train movement in India

Southern Railway in India has installed GPS-enabled `station identification and display boards' on the Madurai-Chennai-Madurai Vaigai and Tiruchi-Chennai-Tiruchi Pallavan superfast expresses to give information on train movements to passengers, especially foreigners. They have been set up in the air-conditioned chair car coaches. *www.hindu.com*

Products

Blue Marble introduces FlexLM licensing

Blue Marble Geographics has announced an update to their Geographic Calculator software application aimed at improving GIS data management efficiency. The Geographic Calculator is known for its easy-to-use interface that allows the user to perform simple coordinate transformations while at the same time allowing for very elaborate in-depth conversions. *www.bluemarblegeo.com*

Rikaline GPS 6036 bluetooth receiver

The Rikaline International Corp., Taiwan a professional hi-tech products provider focusing on GPS and its related application launches Rikaline GPS 6036 Bluetooth receiver featuring SiRFStar III GPS chipset and a host of advanced features. *www.mobilewhack.com*

Leica Geosystems launches Leica PaveSmart 3D

Leica Geosystems announced the launch of Leica PaveSmart 3D for Curb & Gutter paving applications - another first in machine automation. Leica PaveSmart 3D for Curb & Gutter is the world's first fully-automated 3D all-track grade and steer control system for concrete paving equipment. Based on a completely new modular 3D software platform, and utilising Leica Geosystems' unique X-Function dataflow concept, PaveSmart 3D lays the foundation for Leica Geosystems' next generation of machine control systems for the paving industry. *www.leica-geosystems.com*

u-blox unveils GPS evaluation and visualization tool 'u-center mobile'

u-blox AG, Switzerland introduces u-center mobile, a GPS evaluation and visualization tool for Windows Mobile-based Pocket PC handheld devices such as PDAs. u-center mobile is the handheld version of u-center, u-blox' PC-based GPS evaluation software, launched in 2001. *www.u-blox.com*

MapInfo releases MapMarker Plus v12.0

MapInfo Corporation introduced has introduced on MapMarker Plus v12.0, a geocoding tool. MapMarker Plus v12.0 outperforms current geocoding technology, adding a new patent-pending algorithm that more precisely identifies locations. MapMarker Plus v12.0 delivers data-building tools and interpolation methodologies that bring companies as close as 75 feet on average to a given address, closer to its actual location on the ground. *www.mapinfo.com*

AgGPS EZ-Boom 2010 automated application control system

Trimble has introduced its AgGPS EZ-Boom 2010 automated application control system. The system is designed to help farmers cut input costs and reduce operator fatigue by providing precise automatic control of field spraying applications. The new AgGPS EZ-Boom 2010 system works with the Trimble AgGPS EZ-Guide Plus lightbar guidance system, AgGPS EZ-Steer assisted steering system or the AgGPS Autopilot automated steering system. *www.trimble.com*

Autodesk Government Geospatial Solution

Autodesk Inc. announced the availability of a new government geospatial bundle that combines Autodesk's powerful GIS products with Google Earth Pro; empowering business users to leverage highly technical spatial data via an intuitive and easy-to-use interface. The bundle is called the Autodesk Government Geospatial Solution with Google Earth Pro, and is available on the General Services Administration's (GSA) Schedule 70. *www.finanznachrichten.de*

3G MobileBridge for mobile intelligent transportation systems

Top Global has introduced 3G MobileBridge communications gateway for mobile intelligent transportation systems (ITS). The MobileBridge is a patented, mobile/portable wireless system. It is an integrated 3G mobile IP communications gateway. The MobileBridge currently supports all 3G standards including EDGE, UMTS, HSDPA, CDMA 1x, EVDO, and EVDO Rev. A. It will also support mobile WiMax and HSUPA. With EVDO Rev.A, the MobileBridge delivers up to 3.1Mbps download and 1.8Mbps peak upload speed, thus many innovative mobile and wireless applications can now be delivered. *www.topglobalusa.com*

Business

Intergraph to be acquired by investor group

Intergraph Corporation announced on August 31 that it has signed a definitive agreement to be acquired by an investor group led by Hellman & Friedman LLC and Texas Pacific Group in a transaction valued at approximately $1.3 billion. Under the terms of the agreement, Intergraph stockholders will receive $44.00 in cash for each share of Intergraph common stock, representing a 22% premium over Intergraph's average closing share price for the last twenty trading days. *www.intergraph.com*

NGIS to lead the development of NSW spatial information strategy

NGIS Australia, in partnership with Spatial Strategies Pty Ltd, has been selected to lead the development of an overall spatial information strategy for NSW as part of an ongoing Board of Surveying and Spatial Information (BOSSI) project. *www.ngis.com.au*

Geokosmos completes GIS project for gas industry

Geokosmos, the leading company in the Russian and CIS topographic and geodetic survey market, has successfully completed the largest GIS project for gas industry. The project was initiated by Gazprom Joint Stock Company and Urengoygazprom Ltd., the owners of the vast gas field areas in the Tyumen Region (Western Siberia). This territory is characterized by compound landscape (tundra, swamp lands) and severe environmental conditions with cool summer (around +15°C) and very cold winter (around -30°C). The project is focused on land survey, land management and land inventory. It is for the first time when the state-of-the-art airborne laser scanning and terrestrial laser scanning technologies have been used in such a large-scale project not only in Russia but in whole Europe as well. *www.geokosmos.ru*

Thales navigation is now Magellan

An investment group led by Shah Capital Partners (SCP) has announced they have completed the acquisition of Thales Navigation, a division of Thales. The new company will be known as Magellan, and is a leader in the consumer, survey, GIS and OEM GPS navigation and positioning markets. *corp.magellangps.com.*

EADS to set up technology center in India

EADS is committed to supporting India in the development of both its aerospace infrastructure and its industrial capabilities in aviation, space and defence technology. This was announced by EADS CEO Tom Enders during meetings in New Delhi with Indian top officials. A significant step will be the opening of the EADS Technology Centre India. This campus-style institution will bring both the EADS subsidiaries and the Indian partners under the same roof, performing engineering and information technology services. *www.moneycontrol.com*

$3.9 million contract to Intermap Technologies

Intermap Technologies Corp. announced that its Intermap Federal Services, Inc. subsidiary has received a US$3.9M contract to provide digital elevation data and orthorectified radar imagery for an international project. The contract will deliver data for geography never before mapped to the accuracy provided by Intermap's Interferometric Synthetic Aperture Radar (IFSAR) technology. Under the agreement, Intermap will provide radar mapping services for the client over the next six-months. *www.intermap.com.*

PCI Geomatics to create accurate SPOT satellite images for Canada

PCI Geomatics has been awarded a contract from Iunctus Geomatics to produce accurate satellite images covering all of Canada, south of 80° North latitude. The five-year contract, which involves both the delivery of software and production services, is part of Natural Resource Canada's (NRCan) $2.4 million award to Iunctus Geomatics and TELUS Corporation for the creation of new, high-quality images of Canada from SPOT 4 and 5 satellite data. *www.pcigeomatics.com*

Rolta announces joint venture with Thales

Rolta has announced ts joint venture (JV) with Land & Joint Systems division of Thales, to be headquartered in Mumbai in India. To be owned 51% by Rolta and 49% by Thales, the JV will take advantage of technology transfer from Thales for developing state-of-the-art Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance (C4ISTAR) information systems, for domestic and international markets. The initial authorised capital of the joint venture will be Rs. 50 crore (USD 10.5 million). *www.hindu.com*

GeoEye selects BAE Systems' software for 3D mapping of airports

GeoEye has selected BAE Systems' SOCET SET and ClearFlite software for a project that will create 3-D maps for hundreds of airports worldwide. Pilots and air traffic controllers will be able to use the new maps to guide aircraft into and out of airports. The National Geospatial intelligence Agency (NGA) had awarded GeoEye a $3.7 million contract in June to complete the 3D mapping project, which involves the creation of airport mapping databases for 365 airports by June 2007. *http://home.businesswire.com*

Smart Antenna reference design

Sarantel and u-blox AG has announced the availability of a new "Smart Antenna" reference design that will shorten time-to-market and reduce the risk of GPS integration for products ranging from personal navigators to multimedia players with built-in navigation functions. The new design uses Sarantel's GeoHelix®-P2 GPS antenna and the high sensitivity LEA-4S GPS module from u-blox. *www.u-blox.com*

CARIS Hydrographic Production Database Adopted by Ecuador

CARIS has announced that the Oceanographic Institute of the Navy of Ecuador (INOCAR) has selected CARIS Hydrographic Production Database (HPD) in order to move to database-driven hydrographic production system. INOCAR has selected a full implementation of HPD which will include HPD Server, Source Editor, S-57 ENC Editor and Paper Chart Editor. A ten-day training session is being planned now and will be hosted in Ecuador shortly. *www.caris.com.*

Siemens wireless modules XT75 and XT65

In December 2006, the Siemens Communications Group, Munich will bring to market two new modules for tracking and navigation applications: the XT75 and the XT65. Both modules contain a GPS receiver that allows global positioning, and EDGE or GPRS technology for transmitting data to a mobile device. The modules are based on JavaT and have quadband capability, which means they can be used in all GSM mobile networks worldwide. *www.siemens.com*

TeleNav launches 3D GPS navigation service

TeleNav Inc., USA has launched TeleNav GPS Navigator(TM) 5.0, the first GPS application on mobile phones with full-colour three dimensional moving maps. Accompanying the maps are either voice or visual directions with real-time construction and traffic updates. *http://home.businesswire.com*

Traffic routing using cell phone positioning data

IntelliOne, Atlanta, has developed the TrafficAid system that could not only help guide drivers around tie-ups, but also tell emergency responders where accidents are or how effectively an evacuation is unfolding by pinpointing clusters of cell phones. The system can take anonymous cell-phone location information and turning it into an illuminated traffic map that identifies congestion in real time. The system takes advantage of the steady stream of positioning cues--untraced signals all cell phones produce, whether in use or not, as they seek towers with the strongest signals. *http://intellione.com*

Sanyo 6600 Katana with GPS applications

Qwest Communications International Inc., USA announced that Qwest Wireless(R) is offering its thinnest-ever wireless phone, Sanyo 6600 Katana with GPS applications. Beyond its slim and lightweight silhouette, measuring less than six-tenths of an inch thick and weighing just 3.4 ounces, the Katana is capable of downloading premium applications, including a global positioning application with full-colour maps and turn-by-turn directions (with subscription to additional features). *www.qwest.com*

Wasp Barcode Technologies upgrades asset tracking software

Wasp Barcode Technologies announced the release of its upgraded MobileAsset v5 asset tracking software, which enables companies to capture, manage, view, report and track company assets. The solution's Pro version sets a new standard for asset tracking, with new features for linking multiple assets as a group, so they can be tracked as a single asset assigned to a user or physical location. *www.waspbarcode.com*

AllSport GPS turn your phone into a workout tool

AllSport GPS is new software that can turn GPS equipped phone into a powerful training tool. Currently the application is available on some phones, mostly made by Motorola, Nextel and Boost. The AllSport GPS Silver package uses GPS to track the distance covered in the workout, the time it takes, speed, and the calories burn. *www.mobilemag.com*

Sony plans to include GPS in PSP

Sony, USA plans to pump up the volume for the PSP. Some of the upgrades include a GPS, a camera with a built in microphone and the ability to download videos and music via the internet.When the PSP was first launched in 2005, Sony's main focus was the gaming capabilities and the UMD movie format. The GPS will be a great addition to the PSP. *www.mygamer.com*

Arirang 2 sends first photographs

A multipurpose satellite that South Korea launched into space in July, has sent back its first photographs, proving that the images provided by Arirang 2 are vivid enough to distinguish small objects on the ground. The Ministry of Science and Technology and the Korea Aerospace Research Institute (KARI) unveiled the images from the high-resolution cameras of Arirang 2. *http://english.hani.co.kr*

NASA, NOAA data indicates ozone layer on the mend

A new study using NASA and National Oceanic and Atmospheric Administration (NOAA) data finds consistent evidence that Earth's ozone layer is on the mend. A team led by Eun-Su Yang of the Georgia Institute of Technology, Atlanta, analyzed 25 years of independent ozone observations at different altitudes in Earth's stratosphere, which lies between six and 31 miles above the surface. The researchers concluded the Earth's protective ozone layer outside of the polar regions stopped thinning around 1997. Ozone in these areas declined steadily from 1979 to 1997. The abundance of human-produced ozone-destroying gases such as chlorofluorocarbons peaked at about the same time (1993 in the lowest layer of the atmosphere, 1997 in the stratosphere). Such substances were phased out after the 1987 international Montreal Protocol was enacted. The researchers concluded approximately one half the observed ozone change was in the region of the stratosphere above 11 miles and the rest in the lower stratosphere from six to 11 miles. The researchers attribute the ozone improvement above 11 miles almost entirely to the Montreal Protocol. *www.nasa.gov*

India's evolves Disaster Management Support Program

The Department of Space has evolved a Disaster Management Support Programme utilizing the capabilities

of space technology. The programme enables providing space-enabled products and services towards supporting disaster management efforts in the country. These services mainly in terms of value added products are generated from satellite, aerial and other collateral information, and emergency communication support. The information provided is mainly in the form of maps dynamically depicting the disaster impact, damages, and also vulnerability.

Indian Ocean tsunami warning system not up to mark

A tsunami warning system is now in place for Indian Ocean countries, but experts said there is still room for improvement in methods to convey the alerts to coastal communities. A tsunami that killed 600 people in Indonesia two weeks ago exposed some shortcomings in a system still being built after the December 26, 2004 disaster that killed almost 2,17,000 people in a dozen Indian Ocean countries, experts at a UN-backed meeting said. Two international agencies issued warnings that the powerful sub-sea earthquake on July 17 could spawn destructive waves crashing into Java's southern coasts. But Indonesian officials in the capital Jakarta did not pass them on to local communities in time. *www.ibnlive.com*

Google asked to identify Korea correctly

The National Geographic Information Institute (NGII) has requested Google Earth to change Japanese terms on the Korean map. The NGII said that it would hand over an English-language map of Korea to Google this month with a request that the U.S. Internet company stop using Japanese terms on the map of Korea. The map agency said that several notable geographical names in South and North Korea are erroneously marked on Google Earth in Japanese. *www.asiamedia.ucla.edu*

China 'tightens' control over foreign surveying, mapping…

China will step up supervision of foreigners who conduct surveys and map areas of the country. Foreign organizations and individuals, who engage in surveying and mapping in scientific research and teaching programs, travel or exploration, must obtain approval from the government and accept supervision, the State Bureau of Survey and Mapping said.

The bureau notice said that foreigners who illegally survey, gather and publish geographical information on China will be severely punished. Chinese partners or translators will be fined if they fail to stop illegal mapping activities as soon as they find out about them. *http://english.people.com.cn*

…and Britain's maps no longer 'censored'

The Ordnance Survey has finally stopped falsifying Britain's maps, almost 80 years after the government first ordered cartographers to delete sensitive sites in the hope of thwarting German bombers.

The popular Landranger series will now show the nuclear warhead plant at Burghfield, near Reading, hitherto shown as a mysteriously empty field although well known to anti-nuclear demonstrators. Other previously hidden installations include the signal interception aerials at RAF Digby in Lincolnshire and the vast underground munitions dump at Glen Douglas in Scotland.

The access road appears for the so-called Corsham Computer Centre in Wiltshire, thought by conspiracy buffs to be Tony Blair's nuclear shelter. The Internet and high-resolution satellite photography have made attempts at hiding sensitive information obsolete and the Cabinet Office security policy division in Whitehall finally agreed this March to scrap the censorship. The maps are being revised in a rolling programme. *www.guardian.co.uk*

In India

- The City Corporation of Tiruchy in the state of Tamil Nadu is hopeful of reviving its ambitious project to map the entire city, for its satellite-based GIS, which was put in cold storage for over a year. *www.newindpress.com*

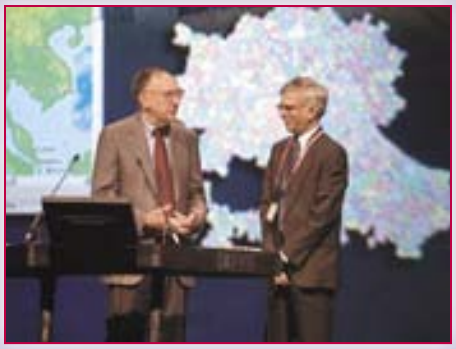
- LeadDog Consulting announces the release of geographic databases of city streets for Delhi, Mumbai, Chennai, Bangalore, Hyderabad, Kolkata, Gurgaon, Noida, Faridabad, and Ghaziabad to support asset-tracking, government, military, and commercial GIS applications. *www.goleaddog.com*

- The Bharathidasan and Madurai Kamaraj universities have undertaken `SCHOOLGIS,' the country's first school mapping project, using GIS and GPS. With a Rs. 93-lakh grant from the Ministry of Human Resources Development, channelled through Tamil Nadu State Mission for Education- to-All (Sarva Siksha Abhiyan), the project entails mapping of 56,000 primary schools and 65,000 hamlets. *www.hindu.com*

- The Kolkata Port Trust (KoPT) has become the first organisation in the Indian port sector to adopt the GIS for management of its 11,000 acre estate spread around Kolkata, Howrah, Budge Budge and Haldia. The GIS software, which has been launched at a cost of Rs. 15 lakh, would enable the port to increase revenue realisation from its landed roperty that has been long suffering. *http://cities.expressindia.com*

- The Urban Development Ministry recently launched National Urban Information Scheme (NUIS) aimed at achieving better planning and management of urban settlements. The Rs. 68.28-crore Urban Development Ministry initiative will in its first phase cover 137 cities and towns across the country. *http://timesofindia.indiatimes.com*

Dr N Vijayaditya receives Distinguished Service in GIS Award



Dr N Vijayaditya, Director General, National Informatics Centre, Government of India receives Distinguished Service in GIS award at 26th Annual ESRI User Conference held at San Diego, USA during 7-11 August 2006.

On the occasion, while speaking to Coordinates, Dr N Vijayaditya, highlighted the importance of geo-information technology for the developmental purposes. He told that there are 23 layers of information on various aspects that can play an important role in micro-level planning, water management, land resources, disaster management, urban planning, establishing in network for mobile communication, etc.

Although the present information system is accessible to the government departments only, such information systems are already making a difference. Now the government department recognizes the importance and applicability of this technology tool.

MARK YOUR CALENDAR

September 2006

Second International Symposium on Geoinformation and Disaster Management
25-26 September, Goa, India
subhan_kp@sac.isro.gov.in
http://www.commission4.isprs.org/

ION GNSS 2006
26 - 29 September, Fort Worth TX, USA
www.ion.org/meetings#gnss

October 2006

27th Asian Conference on Remote Sensing
9-13 October, Ulaanbaatar, Mongolia
www.acrs2006.mn

Intergeo 2006
10 -12 October, Munich, Germany
ofreier@hinte-messe.de
http://www.intergeo.de

XXIII International FIG Congress
8-13 October 2006, Munich Germany
http://www.fig2006.de/

LBS World Forum
16-17, October
San Francisco, CA, USA
marketing@marcusevansmo.com

The 12th IAIN World Congress 2006
18-20 October, Jeju, Korea
http:// 203.230.240.83/

Geoinformatics 2006
28-29 October, Wuhan, China
lilyshi@lmars.whu.edu.cn

November 2006

GSDI-9 - Geospatial Information: tool for reducing poverty
03-11 November, Santiago de Chile, Chile
gsdi9@igm.cl
http://www.igm.cl/gsdi9

Trimble Dimensions
05 - 08 November, Las Vegas NV
http://www.trimble.com

AFITA-2006
9-11 November, 2006
The Indian Institute of Science, Bangalore
http://www.afita2006.org

GIS-IDEAS 2006
9-11, November
Ho Chi Minh City (HCMC), Vietnam
http://wgrass.media.osa-ka-cu.ac.jp/gisideas06/

The 12th IAIN World Congress 2006
18-20 November, Korea
jkinpr@mail.hhu.ac.kr

XXVI INCA International Congress
New Delhi
November 23-25, 2006
siva_k@nic.in, colbhat@yahoo.com

Southeast Asian Geography Association Conference (NIE-SEAGA) 2006
28-30 November, Singapore
www.hsse.nie.edu.sg/staff/changch/seaga/seaga2006.htm

December 2006

GEO-INFORMATICS
8-9, December
V.P.M's Polytechnic,Thane(Maharashtra)
geo_vpm@rediffmail.com

January 2007

Second Asia Pacific Conference for ESRI Users
18-19 January 2007
The Taj Palace Hotel
New Delhi
www.esriindia.com/apuc2007

February 2007

Geomatica 2007: Geomatics for Development
12-16 February Havana, Cuba
www.informaticahabana.com/

June 2007

27th ESRI International User Conference
18-22 June San Diego, California USA
www.esri.com

July 2007

Cambridge Conference 2007
15-20 July Cambridge, UK
www.ordnancesurvey.co.uk/

NEGeo 2006

Northeast India's first conference and exhibition on Geo-information Technologies

21 – 22 September, 2006

Assam Administrative Staff College, Guwahati, Assam

www.mycoordinates.org/negeo

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