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POSITIONING, NAVIGATION AND BEYOND

ELLIPSOIDAL HEIGHTS AND ENGINEERING APPLICATIONS

Security concerns about maps are at times overplayed – Lt Gen Ranjit Singh

India should have its own positioning satellite system – K Ramalingam

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Articles

Columns

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On a different note?

What leads us to make a map?

A desire to locate from anything to everything on the earth.

A quest to know about ourselves, about our surroundings, our earth, our universe.

Or simply a desperation to find a footing on this vast earth?

In India, map making was intimate with imperialism. Partially to understand this mystical land but more importantly to conquer and exploit.

Security of maps was considered very important.

That began the legacy.

'National Security' is a potent term that has the potential to blunt any advocacy of sharing of spatial information.

Hence, it is not a simple statement when Lt Gen Ranjit Singh, SM, Engineer-in-Chief and Senior Comdt, the Corps of Engineers, Indian Army in an interview with Coordinates says, "Security concerns about maps are at times overplayed." *(Interview on page 6)*.

It reflects the changing perception, approach and strategies even in security forces in dealing with the issues associated with geo-spatial information in an era of fast changing technologies.

Bal Krishna, Editor
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"Security concerns about maps are at times overplayed"

says Lt Gen Ranjit Singh, SM, Engineer-in-chief and Senior Col Comdt, the Corps of Engineers, Indian Army while discussing the importance and role of geo-spatial technologies in defence

What are the activities of the Corps of Engineers?

The Corps of Engineers is an arm of army that provides all the combat engineering support to the army. We are responsible for the construction and maintenance of the entire infrastructure that's needed by the defence forces. It is our responsibility to facilitate the mobility of our forces whether it is on foot, on road or even by air especially in border areas. It is our job to provide infrastructure that helps our troops to fight the battle. In addition, we also erect obstacles in the path of enemy forces.

How important are geospatial technologies in your activities?

Mapping has its roots in military requirements. In fact, maps are the by-products of defence needs only. Geo-spatial technologies have a major role to play in this age of computerisation. We have military survey units to map border areas with the help of satellite imageries. More importantly, we need to have accurate maps (in paper/digital form) in order to plan for the defence of the country.

What challenges do you face while introducing new technologies in your department?

Whatever is needed in introducing the relevant technologies at our end, we do that. However, in government set up, it takes some time as certain procedures have to be followed.

What is your opinion on the access of spatial information for developmental projects vis-à-vis security concerns?

My own perception is that the security concerns are at times over played. Many countries do have the digital maps of their adversaries. In addition, one can get very sensitive information from many other sources. Google earth is one such example. It was not long ago when taking a photograph at airports was prohibited in India. Such rules are silly and

Lt Gen Ranjit Singh, SM, assumed the coveted appointment of the Engineer-in-Chief and Senior Colonel Commandant of the Corps of Engineers on 01 Feb 2005. He has had an illustrious career in the Army spanning nearly 40 years.

He is a graduate from Defence Services Staff College, and has attended the prestigious Higher Command Course and the internationally reputed National Defence College.

He was Chief Engineer of the Border Roads Project in Bhutan, where he was involved in planning, execution, monitoring and financial control of works worth in the Himalyan Kingdom.

He was later Chief Engineer of Eastern Command, Kolkata, where he was responsible for planning and technical supervision of infrastructure development works for the Eastern Army. As Director General (Works) in Army HQ, he was responsible for planning/designing of all major/ specialised works executed by the Military Engineer Services.

Before Engineer-in-Chief, he was holding the appointment of Director General Border Roads, where he was the executive head of the Organisation and was responsible for perspective planning and management of 13 Projects involved in construction and maintenance of Roads, Bridges, Airfields in North India, the North East, as well as abroad.

He is a member of Indian Building Congress, Indian Road Congress and International Project Management Association. He is a fellow of Indian Institute of Bridge Engineers and of Institution of Engineers. He is also on Board of Governors of Construction Industry Development Council.

He is a keen sportsman and an outstanding sailor. He is presently Executive Vice President of Yatching Association of India, and the Canoeing and Kayaking Association of India. He has been bestowed with Eminent Engineer Award on 38th Engineer Day on 15 Sep 2005 by the Institution of Engineers (India).

ridiculous. As far as the debate goes, it will continue as there will always be security concerns which will need to be balanced with the need to make maps available to the private individuals/organizations for their use.

How do you see the proposed introduction of open series maps for civilian use?

It is a right step. For civilian purposes, one does not require highly accurate and detailed maps. The needs are different. Hence, enabling access to non-sensitive geo-spatial information for developmental projects and civilian purpose is a welcome step.

The GPS system is under US control. Is it sensible to depend on this system?

We must understand that nowadays weapons are very lethal and have potential to inflict considerable damage. We have seen that in the recent Iraq war. It is essential to have a dependable guidance system to pin point the target and avoid collateral damage. Hence, it will be appropriate and important to explore the other options in this regard. If I go by the newspaper reports, I understand that the Government of India is evaluating and exploring other options also.

How do you see the growth of geomatics in India?

There is a vast difference in the way we used to map and the way we do it now. The growth in this technology is visible and perceptible. You can see this in the ongoing research in various academic institutes and the increasing demand for geo-spatial information for various projects. In addition, the growth of industry in this segment in recent years also reveals the potential in this field. Awareness about such technologies is very high and that's very good, as that ensures a promising future for these technologies.

Under the lens: 'Right' vs 'rights'

The New York Civil Liberties Union has challenged curbs on people's right to photograph public places

Filmmaker Rakesh Sharma has sued New York City for being `detained and harassed' by its police while making a documentary about ordinary folks in a post-9/11 world. Backing Sharma's suit, the New York Civil Liberties Union has challenged curbs on people's right to photograph public places. Police officers confronted Sharma in May 2005 for allegedly filming a "sensitive building". They interrogated him for three hours. Despite "cooperating with them, they treated me like a criminal," the maker of *Final Solution*, a documentary on the Gujarat riots, said. Mr Sharma was told he needed a permit to film on city streets and then was denied one without explanation when he applied to the Mayor's Office of Film, Theatre and Broadcasting, the lawsuit said. (*Hindustan Times*, January 12, 2006, New Delhi).

How to interprete this? Is it a scar of terror or a scare of terrorism? Is photography of a public place in New York illegal? I was surprised. Had such an incident occurred in any of the many countries that practice strict information regime, I would have not reacted. But when such incident happens in a country that champions all kind of 'rights' and 'rights' and at times does not mind going to any extent to enforce its 'rightful' prescriptions, it raises many questions. Instead of dealing with the issues raised by Mr Rakesh Sharma about harassment and humiliation in US, my concern is the law itself that supposedly prohibits taking pictures of public places. Existence of such laws in a mighty country like US further strengthens the arguments that advocate the restriction on the flow of the nature of information in public domain mostly in the name of national security. Worse, it does dampen and weaken the spirit of those who favour a liberal policy of information sharing. These people contest the basic logic of restriction on the ground that in most of the cases what we try to hide is already available in public domain.

In fact, the pace of technological changes in the field of data capturing and its dissemination is forcing the concerned authorities to redefine their perception, approach and strategies. It was not long ago that clicking a photograph in an airport in India was prohibited. In the interview on page 6, this rule was termed as "silly and ridiculous" by Lt Gen Ranjit Singh, SM, Engineer-in-chief and Senior Col Comdt, the Corps of Engineers, Indian Army. On one hand, when a country like India is making efforts to make available spatial data for civilian and developmental purposes through landmark initiatives like the National Map Policy and National Spatial Data Infrastructure, such events taking place in other parts of the world indicate a very different trend. Anyway, in an era of 'multiple standards' when different yardsticks are applied to different people in similar situations, it is a challenge to explore and evolve innovative responses in dealing with security needs and civil liberties.

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Wide-lane kinematic positioning in multiple frequencies

In the present paper, a method making a long baseline kinematic positioning possible in the present dual frequency system is discussed

H Isshiki

The biggest problem in the high precision kinematic positioning is the determination of the initial phase ambiguity of L_1 wave. It may be said that a complete solution is not obtained for this problem in case of the long baseline positioning. The factors making the ambiguity determination difficult in case of long baseline kinamatic positioning are the satellite orbit errors, the ionospheric delays and the tropospheric delays. The ionospheric delays may be the most important. An epoch making progress is expected after GPS Modernization and Galileo take place in near future (Hatch (1996), Isshiki (2003a, b)). The present GPS are a dual frequency system. The signals consist of L_1 signal of 1.57 GHz and L_2 signal of 1.23 GHz. It may be impossible to solve the above-mentioned problem completely, since no methods can determine both the initial phase ambiguity and the ionospheric delay simultaneously. When GPS Modernization is realized and L_5 wave of 1.18 GHz is added to the present dual frequency system, the two independent geometry free combination are obtained for each satellite and receiver combination. Hence, the simultaneous determination of the initial phase ambiguity and the ionospheric delay become possible theoretically. So, if the determination of the wide-lane ambiguity by HMW (Hatch-Melbourne-Wübbena) combination is also used, L_1 ambiguity may be determined without being assisted by any external sources and without being affected by the ionospheric delay.

In the present paper, a method making a long baseline kinematic positioning possible in the present dual frequency system is discussed.

Multi-frequency observation equations and the solution

Multiple frequency observations are essential for long baseline positioning. Let t refer to time and $P^i_{\kappa\alpha}(t)$ and $\Phi^i_{\kappa\alpha}(t)$ be the pseudo range and the phase range of L_κ wave between the satellite i and the receiver α. $\rho^i_\alpha(t)$ is the true geometric range. $I^i_\alpha(t)$ and $T^i_\alpha(t)$ are the ionospheric and the tropospheric delays of L_1 wave. The light speed in vacuum is denoted by c . Then, the double difference observation equations are given as (Isshiki (2003a, b, c, 2004))

$$P^{ij}_{\kappa\alpha\beta} = \rho^{ij}_{\alpha\beta} + \left(\frac{f_1}{f_\kappa}\right)^2 I^{ij}_{\alpha\beta} + T^{ij}_{\alpha\beta} + e^{ij}_{\kappa\alpha\beta}, \quad (1a)$$

$$\Phi^{ij}_{\kappa\alpha\beta} = \rho^{ij}_{\alpha\beta} - \left(\frac{f_1}{f_\kappa}\right)^2 I^{ij}_{\alpha\beta} + T^{ij}_{\alpha\beta} + \lambda_\kappa N^{ij}_{\kappa\alpha\beta} + \varepsilon^{ij}_{\kappa\alpha\beta}, \quad (1b)$$

where

$$(\bullet)^i_{\alpha\beta} = (\bullet)^i_\alpha - (\bullet)^i_\beta, \quad (2a)$$

$$(\bullet)^{ij}_\alpha = (\bullet)^i_\alpha - (\bullet)^j_\alpha, \quad (2b)$$

$$(\bullet)^{ij}_{\alpha\beta} = (\bullet)^i_{\alpha\beta} - (\bullet)^j_{\alpha\beta} = (\bullet)^{ij}_\alpha - (\bullet)^{ij}_\beta. \quad (2c)$$

If the errors are neglected in the observation equations for L_κ and $L\mu$ waves, $\rho^{ij}_{\alpha\beta}(t) + T^{ij}_{\alpha\beta}(t)$, $I^{ij}_{\alpha\beta}$, $N^{ij}_{\kappa\alpha\beta}$ and $N^{ij}_{\lambda\alpha\beta}$ are expressed in terms of $P^{ij}_{\kappa\alpha\beta}(t)$, $P^{ij}_{\lambda\alpha\beta}(t)$, $\Phi^{ij}_{\kappa\alpha\beta}(t)$ and $\Phi^{ij}_{\lambda\alpha\beta}(t)$.

The initial phase ambiguity $N_{W(\kappa\lambda)}{}^{ij}{}_{\alpha\beta}$ wide-lane combination of L_κ and L_μ waves is obtained as

$$N_{W(\kappa,\lambda)}{}^{ij}_{\alpha\beta} = N^{ij}_{\kappa\alpha\beta} - N^{ij}_{\lambda\alpha\beta} = \frac{\Phi^{ij}_{\kappa\alpha\beta}(t)}{l_\kappa} - \frac{\Phi^{ij}_{\lambda\alpha\beta}(t)}{l_\lambda} - \frac{f_\kappa - f_\lambda}{f_\kappa + f_\lambda}\left(\frac{P^{ij}_{\kappa\alpha\beta}(t)}{l_\kappa} + \frac{P^{ij}_{\lambda\alpha\beta}(t)}{l_\lambda}\right), \quad (3)$$

where f_κ and l_κ are the frequency and wave length of L_κ wave. Equation (3) is HMW (Hatch- Melborne-Wübbena) combination (Hatch (1996), Isshiki (2003b)). When κ =1 and λ = 2 in equation (3), $f_1 \approx 1.58$GHz and $f_2 \approx 1.23$GHz and then $(f_1 - f_2)/(f_1+f_2) \approx 0.124$. So, the error introduced by the pseudo ranges is reduced to 1/10. HMW combination is free from the ionospheric and tropospheric delays. So, the wide-lane ambiguities can be calculated precisely without being affected by the baseline length. The average over epochs can eliminate the random errors effectively.

The wide-lane combination $\Phi_{W(\kappa,\lambda)}{}^{ij}{}_{\alpha\beta}(t)$ of $\Phi^{ij}_{\kappa\alpha\beta}(t)$ and $\Phi^{ij}_{\kappa\alpha\beta}(t)$ is given as

$$\Phi_{W(\kappa,\lambda)}{}^{ij}_{\alpha\beta}(t) \equiv \frac{l_{W(\kappa,\lambda)}}{l_\kappa}\Phi^{ij}_{\kappa\alpha\beta}(t) - \frac{l_{W(\kappa,\lambda)}}{l_\lambda}\Phi^{ij}_{\lambda\alpha\beta}(t)$$
$$= \rho^{ij}_{\alpha\beta} - \left[\frac{l_{W(\kappa,\lambda)}}{\lambda_\kappa}\left(\frac{f_1}{f_\kappa}\right)^2 - \frac{l_{W(\kappa,\lambda)}}{\lambda_\lambda}\left(\frac{f_1}{f_\lambda}\right)^2\right] I^{ij}_{\alpha\beta}$$
$$+ l_{W\kappa\lambda}\left(N^{ij}_{\kappa\alpha\beta} - N^{ij}_{\lambda\alpha\beta}\right) + T^{ij}_{\alpha\beta} + \varepsilon_{W(\kappa,\lambda)}{}^{ij}_{\alpha\beta}$$
$$= \rho^{ij}_{\alpha\beta} + \frac{f_1^2}{f_\kappa f_\lambda} I^{ij}_{\alpha\beta} + l_{W(\kappa,\lambda)} N_{W(\kappa,\lambda)}{}^{ij}_{\alpha\beta} + T^{ij}_{\alpha\beta} + \varepsilon_{W(\kappa,\lambda)}{}^{ij}_{\alpha\beta}, \quad (4)$$

where the frequency $f_{W(\kappa,\lambda)}$ and wave length $l_{W(\kappa,\lambda)}$ of the wide-lane combination are defined as and

$$\frac{f_{W(\kappa,\lambda)}}{c} = \frac{f_\kappa - f_\lambda}{c} = \frac{1}{l_\kappa} - \frac{1}{l_\lambda} = \frac{1}{l_{W(\kappa,\lambda)}}, \quad (5)$$

$\varepsilon_{W(\kappa,\lambda)}{}^{ij}{}_{\alpha\beta}$, is the error of $\Phi_{W(\kappa,\lambda)}{}^{ij}{}_{\alpha\beta}(t)$.

In case of a triple frequency system like Galileo and the future GPS, two independent wide-lane combinations can be formed. If an ionospheric-free combination is obtained by eliminating the ionospheric delay $I^{ij}_{\alpha\beta}$, an unambiguous observation equations may be obtained. So, the coordinates may be determined without being affected by the ionospheric delay by solving the equations epoch by epoch (Hatch (1996)). However, if the difference between the frequencies is small, the error is magnified. So, the multi-path error, will invite rather big errors in the coordinates. For the wide-lane positioning in a dual frequency system like the present GPS, the ionospheric delay $I^{ij}_{\alpha\beta}$ has to be estimated. The varying component of $I^{ij}_{\alpha\beta}$ may be estimated precisely by the geometry-free combination $\Phi_{G(\kappa,\lambda)}{}^{ij}{}_{\alpha\beta}(t)$ of $\Phi^{ij}_{\kappa\alpha\beta}(t)$ and $\Phi^{ij}_{\lambda\alpha\beta}(t)$ as

$$\Phi_{G(\kappa,\lambda)}{}^{ij}_{\alpha\beta}(t) \equiv \Phi_{\kappa\alpha\beta}^{\ ij}(t) - \Phi_{\lambda\alpha\beta}^{\ ij}(t)$$

$$= -\left[\left(\frac{f_1}{f_\kappa}\right)^2 - \left(\frac{f_1}{f_\lambda}\right)^2\right] I^{ij}_{\alpha\beta}(t) + l_\kappa N_{\kappa\alpha\beta}^{\ ij} - l_\lambda N_{\lambda\alpha\beta}^{\ ij}$$

$$+ \varepsilon_{G(\kappa,\lambda)}{}^{ij}_{\alpha\beta}(t), \qquad (6)$$

where $\varepsilon_{G(\kappa,\lambda)}{}^{ij}{}_{\alpha\beta}$ is the error of $\Phi_{G(\kappa,\lambda)}{}^{ij}{}_{\alpha\beta}(t)$. From equation (6), the variation of $I^{ij}_{\alpha\beta}$ is obtained as

$$\left(I^{ij}_{\alpha\beta}(t) - I^{ij}_{\alpha\beta}(0)\right) \approx -\frac{\left[\left(\Phi^{\ ij}_{\kappa\alpha\beta}(t) - \Phi^{\ ij}_{\kappa\alpha\beta}(0)\right) - \left(\Phi^{\ ij}_{\lambda\alpha\beta}(t) - \Phi^{\ ij}_{\lambda\alpha\beta}(0)\right)\right]}{\left[\left(\frac{f_1}{f_\kappa}\right)^2 - \left(\frac{f_1}{f_\lambda}\right)^2\right]}. \qquad (7)$$

Now, $I^{ij}_{\alpha\beta}$ is written as

$$I^{ij}_{\alpha\beta}(t) = I^{ij}_{\alpha\beta}(0) + \left(I^{ij}_{\alpha\beta}(t) - I^{ij}_{\alpha\beta}(0)\right). \qquad (8)$$

The first term on the right side of equation (8) must be estimated from the other information included in the observation or supplied from the external source as IONEX (Global estimate of the ionospheric delays by JPL).

First, equation (8) is averaged over N_1 epochs, and $I^{ij}_{\alpha\beta}(0)$ is written as

$$I^{ij}_{\alpha\beta}(0) = \sum_{t=0}^{N_1-1} I^{ij}_{\alpha\beta}(t) - \sum_{t=0}^{N_1-1}\left(I^{ij}_{\alpha\beta}(t) - I^{ij}_{\alpha\beta}(0)\right). \qquad (9)$$

If the error in the pseudo range is small, $I^{ij}_{\alpha\beta}(0)$ derived from the geometry-free combination of the pseudo ranges:

$$I^{ij}_{\alpha\beta}(t) \approx \frac{P_{\kappa\alpha\beta}^{\ ij}(t) - P_{\lambda\alpha\beta}^{\ ij}(t)}{\left[\left(\frac{f_1}{f_\kappa}\right)^2 - \left(\frac{f_1}{f_\lambda}\right)^2\right]} \qquad (10)$$

may be used to estimate the first term on the right side of equation (9) as

$$\sum_{t=0}^{N_1-1} I^{ij}_{\alpha\beta}(t) \approx \frac{\sum_{t=0}^{N_1-1}\left[P_{\kappa\alpha\beta}^{\ ij}(t) - P_{\lambda\alpha\beta}^{\ ij}(t)\right]}{\left[\left(\frac{f_1}{f_\kappa}\right)^2 - \left(\frac{f_1}{f_\lambda}\right)^2\right]}. \qquad (11)$$

In the present GPS system, κ = 1 and λ = 2, $f_1 \approx$ 1.58GHz and $f_2 \approx$ 1.23GHz and $\sigma[P_1{}^{ij}{}_{\alpha\beta}(t)] = \sigma[P_2{}^{ij}{}_{\alpha\beta}(t)] \approx$ 1m. So, the error of $\sum_{t=0}^{N_1-1} I^{ij}_{\alpha\beta}(t)$

is estimated as 0.22m when N_1=100 (1 epoch = 30 sec). This result is rather disappointing.

Next, instead of the pseudo range, the ionospheric delay $I_{IONX}{}^{ij}{}_{\alpha\beta}(t)$ supplied by IONEX is used. Then

$$\sum_{t=0}^{N_1-1} I^{ij}_{\alpha\beta}(t) \approx \sum_{t=0}^{N_1-1} I_{IONX}{}^{ij}_{\alpha\beta}(t). \qquad (12)$$

The error of this estimation may be about 0.1m, not so bad. $I^{ij}_{\alpha\beta}(0)$ determined by Equation (9) and (12) is also a solution of a problem:

$$\partial \sum_{t=0}^{N_1}\left[I^{ij}_{\alpha\beta}(t) - I_{IONX}{}^{ij}_{\alpha\beta}(t)\right]^2 \Big/ \partial I^{ij}_{\alpha\beta}(0) = 0. \qquad (13)$$

Numerical Results

In the following numerical calculations, observation data of fixed stations shown in Table 1 are used. These data were observed by GEONET of GSI (Geographical Survey Institute, Japan) on December 6, 2002 and downloaded from the homepage of GSI. The ionosphere was rather active in 2002. L_1 and L_2 signals of GPS are given there. The epoch is 30 seconds, and the data between 00:00:00 UT and 02:00:00 UT are used for the calculations. The coordinates (x, y, z) of the stations the baseline length dr shown in Table 1 are very precise ones downloaded from the same site. In the following calculations, the precise orbits of the satellites are used, and the tropospheric delays are estimated by Saastamoinen model..

In Table 2, the wide-lane ambiguities of L_1 and L_2 signals calculated by equation (3), that is HMW combinations, are shown. It is verified that the wide-lane ambiguities is determined quite successfully irrespective of the baseline length by HMW combinations.

Figs. 1a and 1b show the baseline lengths of Sppr-Enwa (about 25 km) and Sppr-Ichk (about 800 km) calculated by the wide lane combinations (LW), where the ionospheric delays are neglected. The variations are within ±0.05 m and ±1 m respectively.

Fig. 1a Baseline length dr of Sppr-Enwa calculated by wide-lane combination (Ionospheric delay neglected)

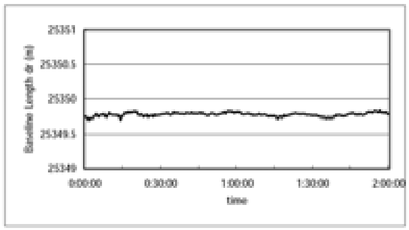


Fig. 1b Baseline length dr of Sppr-Ichk calculated by wide-lane combination (Ionospheric delay neglected)

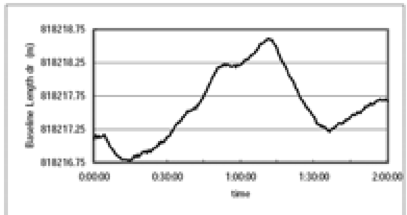


Fig. 2 shows the estimated baseline length of Sppr-Ichk where the ionosphric delays are estimated by IONEX (Global estimate of the ionospheric delays by JPL). The variation is reduced to half, that is, within ±0.5 m. The correct baseline lengths can be calculated from the correct coordinates shown in Table 1. Hence, the errors between the correct and estimated baseline length are obtained. Fig. 3 and 4 shows the effects of ionospheric delays on the errors of mean value and the standard deviations of baseline length. A remarkable decrease of the errors is realized by introducing the ionospheric delays. The improvement may not be sufficient for very precise positioning. However, it may be useful for a variety of applications. If the regional ionospheric estimation becomes available in future, the wide lane positioning may be promising.

Table 1. Station Coordinates (x, y, z) and baseline length dr (GEONET:02.12.06)

Stn Name	Stn.ID	Abrib.	x (m)	y (m)	z (m)	dr (m)
Sapporo	950128	Sppr	-3647449.8988	2923169.2544	4325315.3884	0
Eniwa	960522	Enwa	-3667125.8966	2908882.6546	4318149.1057	25349.7028
Tomakomai	950136	Tmkm	-3681909.5364	2918009.4365	4299470.5844	43382.5338
Muroran	940018	Mrrn	-3664512.7237	2973568.1897	4276499.5883	72209.2446
Hakodate	940022	Hkdm	-3685967.8612	3011795.4107	4231283.2384	134834.2473
Iwaizumi	950164	Iwa2	-3853718.7781	3032158.1369	4065250.0629	349370.0053
Kesennuma	950172	Ksnm	-3647449.8988	2923169.2544	4325315.3884	452359.2301
Ichikawa	93023	Ichk	-3967874.2402	3340981.7058	3699025.1252	818216.6565

Table 2a. Wide-lane ambiguities calculated by HMW combinations (Sppr-Enwa: 02.12.06, 00:00:00UT-02:00:00)

	((05)-(14))	((06)-(14))	((25)-(14))	((30)-(14))
Float (Mean)	2200137.932	-4995375.995	-5336259.061	-562506.032
Fix	2200138.000	-4995376.000	-5336259.000	-562506.000
Std. Dev.	0.031	0.033	0.028	0.023

Table 2b. Wide-lane ambiguities calculated by HMW combinations (Sppr-Ichk: 02.12.06, 00:00:00UT-02:00:00)

	((05)-(14))	((06)-(14))	((25)-(14))	((30)-(14))
Float (Mean)	3945315.988	-8337131.946	-7584052.919	-181954.946
Fix	3945316.000	-8337132.000	-7584053.000	-181955.000
Std. Dev.	0.032	0.031	0.030	0.033

Fig. 2 Baseline length dr of Sppr-Ichk calculated by wide-lane combination (Ionospheric delay estimated by IONEX)

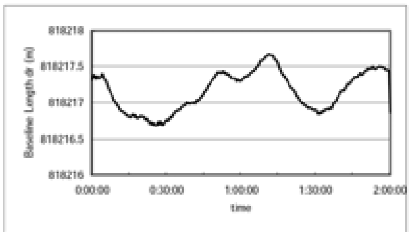


Fig. 3 Effects of ionospheric delays on the errors of mean values of Baseline length (Solid line: Ionospheric delay neglected; Broken line: Ionospheric delay estimated by IONEX)

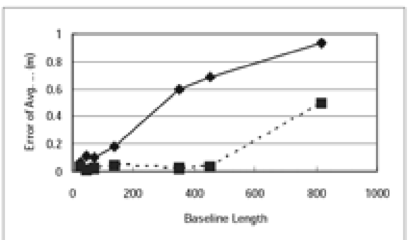
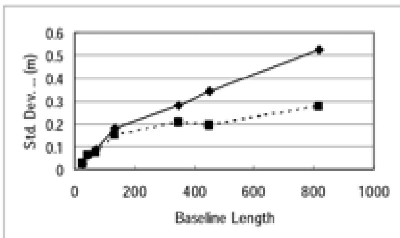


Fig. 4 Effects of ionospheric delays on the standard deviations of Baseline length (Solid line: Ionospheric delay neglected; Broken line: Ionospheric delay estimated by IONEX)



However, as the baseline length increases, the temporally varying components of the ionosphere become big. The temporally varying components can be eliminated by using the geometry-free combinations of the phase ranges.

In the following calculations, the ionospheric delays are calculated by using equations (7), (8), (9) and (12), where N_1 = whole epochs. In Figs. 5 - 8, the calculated ionospheric delays are compared with IONEX itself and the correct ones. The correct ones are obtained by using in equation (6) the wide-lane ambiguity $N_{W(1,2)}{}^{ij}{}_{\alpha\beta}$ and the correct L_1 ambiguities $N_1{}^{ij}{}_{\alpha\beta}$

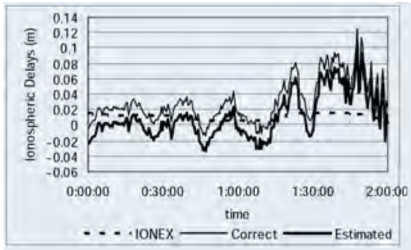


Fig.5a Ionospheric delay for Sppr-Enwa $I^{5}{}_{01}{}^{14}(t)$

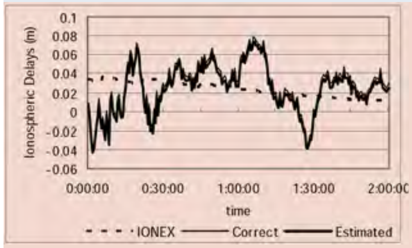


Fig.5b Ionospheric delay for Sppr-Enwa $I^{6}{}_{01}{}^{14}(t)$

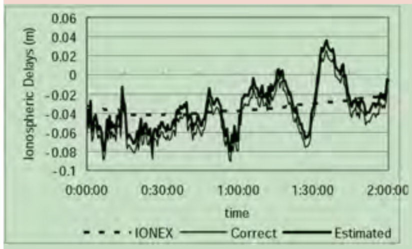


Fig.5c Ionospheric delay for Sppr-Enwa $I^{25}{}_{01}{}^{14}(t)$

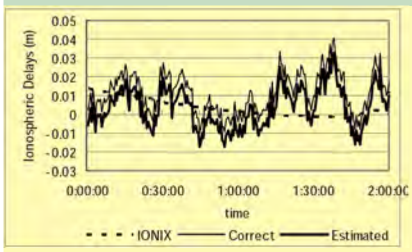


Fig.5d Ionospheric delay for Sppr-Enwa $I^{30}{}_{01}{}^{14}(t)$

determined by the static positioning of the ionosphere-free equation:

$$\Phi_{I(\kappa,\lambda)}{}^{ij}_{\alpha\beta}(t) \equiv \frac{f_\kappa{}^2}{f_\kappa{}^2+f_\lambda{}^2}\Phi_{\kappa}{}^{ij}_{\alpha\beta}(t) - \frac{f_\lambda{}^2}{f_\kappa{}^2+f_\lambda{}^2}\Phi_{\lambda}{}^{ij}_{\alpha\beta}(t)$$
$$= \rho^{ij}_{\alpha\beta}(t) + T^{ij}_{\alpha\beta}(t) + l_{N(\kappa,\lambda)}N_{\kappa}{}^{ij}_{\alpha\beta} - \frac{1}{2}\left(l_{N(\kappa,\lambda)} - l_{W(\kappa,\lambda)}\right)N_{W(\kappa,\lambda)}{}^{ij}_{\alpha\beta}$$
$$+\varepsilon_{I(\kappa,\lambda)}{}^{ij}_{\alpha\beta}(t)\ , \qquad (14)$$

where $\varepsilon_{I(\kappa,\lambda)}{}^{ij}_{\alpha\beta}(t)$ is error, and $f_{N(\kappa,\lambda)}$ and $l_{N(\kappa,\lambda)}$ are defined as

$$f_{N(\kappa,\lambda)} = f_\kappa + f_\lambda\ , \quad l_{N(\kappa,\lambda)} = c/\left(f_\kappa + f_\lambda\right). \qquad (15)$$

The baseline lengths are calculated in Figs. 9 – 12. In these figures, “Ion-free” refers to the baseline length calculated by using the coordinates obtained by kinematic positioning of the ionosphere-free combinations (see equation (14)), where the wide-lane ambiguity $N_{W(1,2)}{}^{ij}_{\alpha\beta}$ (determined by HMW combinations and the correct L_1 ambiguities $N_1{}^{ij}_{\alpha\beta}$ determined by the static positioning of the ionosphere-free equation are used. “Estimated”, “IONEX” and “Neglected” refer to the baseline length calculated by using the coordinates obtained by kinematic positioning of the widelane combinations (see equation (4)), where the wide-lane ambiguity $N_{W(1,2)}{}^{ij}_{\alpha\beta}$ is determined by HMW combinations. At “Neglected”, no ionospheric delays are estimated. At “IONEX”, the ionospheric delays are estimated by IONEX. And at “Estimated”, equations (7), (8), (9) and (12) are used for estimationg the ionospheric delays, where N_1= whole epochs .

The effects of introducing the ionospheric delays in the positioning calculations using the wide-lane combinations are evident from the results shown in Figs. 9 – 12. The introduction of IONEX itself alone improves the results significantly. Furthermore, the estimation of the temporally varying components gives much better results. When the difference between the correct (“Correct”) and estimated (“Estimated”) ionospheric delays in Figs. 5 – 8 is small, the difference between the

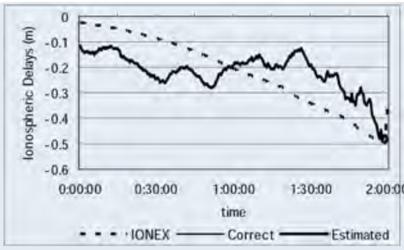


Fig.6a Ionospheric delay for Sppr-Enwa $I^{5}_{01}{}^{14}(t)$

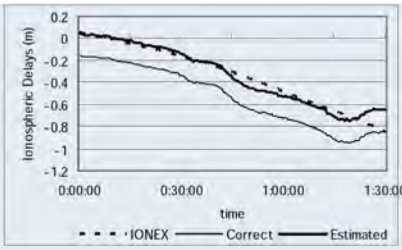


Fig.7a Ionospheric delay for Sppr-Enwa $I^{5}_{01}{}^{14}(t)$

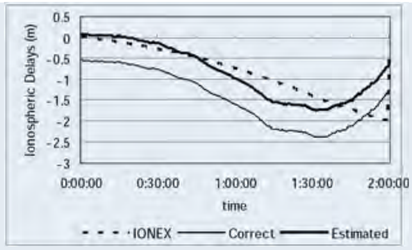


Fig.8a Ionospheric delay for Sppr-Enwa $I^{5}_{01}{}^{14}(t)$

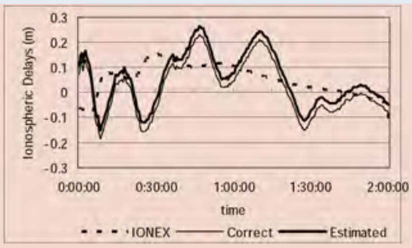


Fig.6b Ionospheric delay for Sppr-Enwa $I^{6}_{01}{}^{14}(t)$

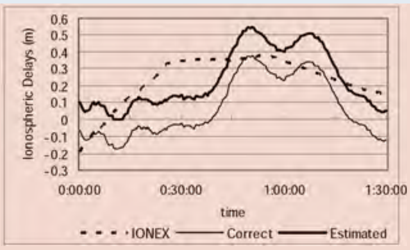


Fig.7b Ionospheric delay for Sppr-Enwa $I^{6}_{01}{}^{14}(t)$

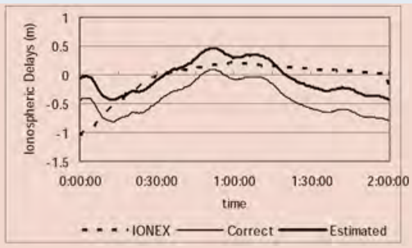


Fig.8b Ionospheric delay for Sppr-Enwa $I^{6}_{01}{}^{14}(t)$

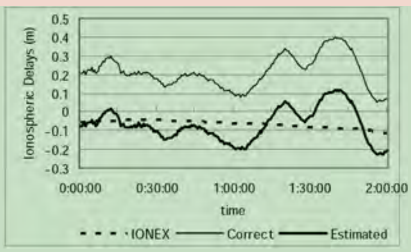


Fig.6c Ionospheric delay for Sppr-Enwa $I^{25}_{01}{}^{14}(t)$

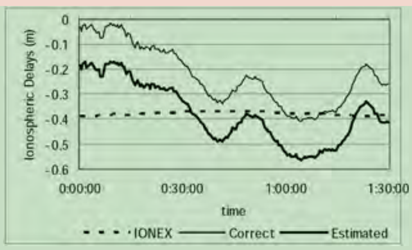


Fig.7c Ionospheric delay for Sppr-Enwa $I^{25}_{01}{}^{14}(t)$

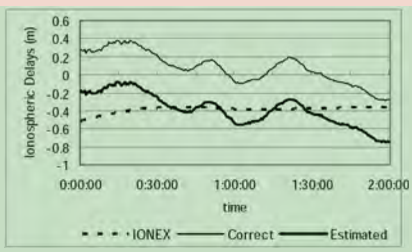


Fig.8c Ionospheric delay for Sppr-Enwa $I^{25}_{01}{}^{14}(t)$

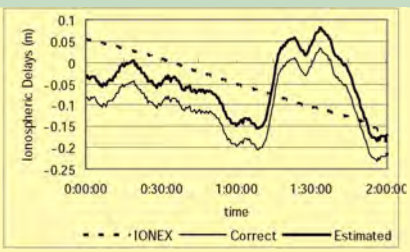


Fig.6d Ionospheric delay for Sppr-Enwa $I^{30}_{01}{}^{14}(t)$

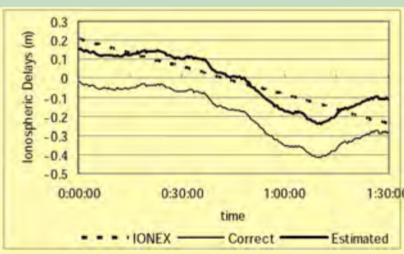


Fig.7d Ionospheric delay for Sppr-Enwa $I^{30}_{01}{}^{14}(t)$

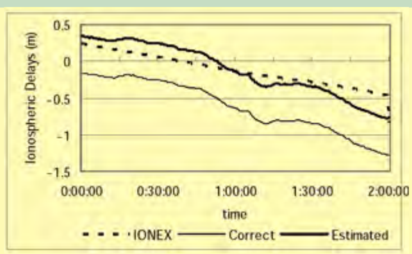


Fig.8d Ionospheric delay for Sppr-Enwa $I^{30}_{01}{}^{14}(t)$

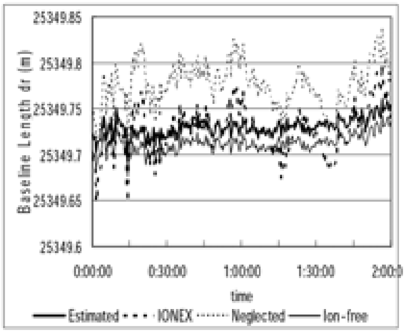


Fig.9 Baseline length dr of Sppr-Enwa caculated by kinematic positioning using wide-lane combination

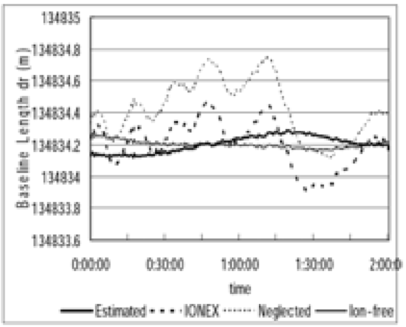


Fig.10 Baseline length dr of Sppr-Hkdm caculated by kinematic positioning using wide-lane combination

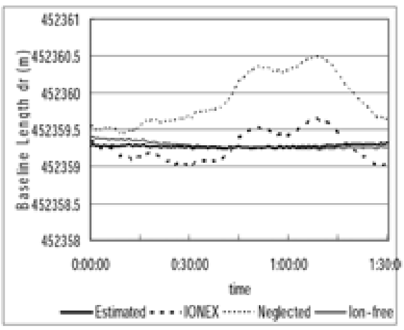


Fig.11 Baseline length dr of Sppr-Ksnm caculated by kinematic positioning using wide-lane combination

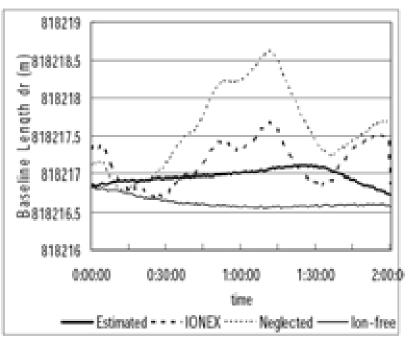


Fig.12 Baseline length dr of Sppr-Ichk caculated by kinematic positioning using wide-lane combination

correct ("Ion-free") and estimated ("Estimated") baseline lengths is also small in Figs. 9 - 12. This means the importance of the precise estimation of the ionospheric delays.

Conclusions

In the present paper, a long baseline kinematic positioning possible under the present dual frequency syatem is discussed. Specifically, The effects of the ionospheric delays on the precision on the estimated coordinates are discussed. In the discussion, the wide lane observation equations are used, since the initial ambiguities of wide lane combinations are calculated easily by using HMW (Hatch-Melbourne-Wübbena) combinations. A remarkable improvement of the precision is realized by introducing the ionospheric delays such as IONEX. However, the improvement may not be sufficient for very precise positioning. The temporally varying components due to the variation of the ionosphere are not estimated precisely in the estimation like IONEX. In the present paper, the improper variation of the coordinates of the receiver due to the variation of the ionospheric delays is also eliminated by using the geometry-free combinations of the phase ranges. If the more precise ionospheric estimation becomes available in future, the precision of the wide-lane positioning may be increased further, and the wide-lane positioning may become one of the precise and convenient positioning methods.

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Born in 1940 in Shizuoka, Japan. Graduated from Department of Naval architecture, University of Tokyo in 1965 and got doctor degree from the same university in 1972 on variational principles in applied mechanics. After working for about one year at College of Engineering, Seoul National University, Korea, joined Technical Research Institute of Hitachi Zosen Corporation in Japan as a ship hydrodynamicist. Retired from the corporation in 2001, and established IMA (Institute of Mathematical Analysis).

For about seven years, taught as a part time lecturer at Faculty of Engineering, Osaka University, Japan on topics such as Swimming of a Fish, Variational Calculus and GPS.

Interested presently in high precision positioning by GPS, water wave theory and flying of an insect such as a dragonfly.

Products

Spectra Precision Laser grade control systems

Trimble has introduced a portfolio of laser-based machine display and control systems for grading and excavating applications. The new Spectra Precision Laser machine systems is said to be highly flexible, extremely rugged and can be used on a wide range of machines, including dozers, backhoes, scrapers, skid steers and excavators. On a dozer, the system can be upgraded for automatic blade control providing even greater productivity gains. The Spectra Precision Laser grade control systems give the operator visual guidance for the cutting edge of the blade or bucket. *www.trimble.com*

Leica SmartRover A cable free RTK GPS system

The new Leica SmartRover is the world's lightest all-on-the-pole RTK GPS system. Consisting of the Leica SmartAntenna ATX1230 and the Leica RX1250 Controller, the Leica SmartRover delivers complete cable free operation to provide maximum flexibility with fewer components. Weighing only 2.8 kg, the Leica SmartRover reduces operator fatigue and maximizes productivity.

Meanwhile, Leica geosystems also introduces a high-performance GPS receiver, Leica GMX902, specially developed to monitor sensitive structures such as bridges, dams or high buildings and crucial topographies such as land slides or volcanoes. It provides precise dual frequency code and phase data up to 20 Hz, enabling precise data capture as the base for highly accurate position calculation and motion analysis.

Topcon technology can access GPS, GLONASS, Galileo

Technology developed by Topcon Positioning Systems came closer to being used on job sites worldwide December 28 when the first satellite in the European Union's (EU) Galileo navigation program was launched. For Topcon users, the launch - and the launch of three additional GLONASS satellites on Christmas Day - puts the spotlight on the company's Paradigm G3 chip - a groundbreaking new technology for satellite positioning systems.

New HP DesignJet 4500 Printer

Hewlett-Packard recently announced the launch of the HP DesignJet 4500 printer, scanner and multi-function printer (MFP). These new large-format solutions increase media feed and output capacity to take productivity to a new level.

The HP DesignJet 4500 printer series has been designed to maximize unattended printer operation. The most distinguishing feature of this printer is the fact that it has extra-large, flexible media input capacity. *www.hp.com*

Microsoft launches Windows Live Local

Microsoft has renamed and upgraded its online mapping service, MSN Virtual Earth beta: it is now called Windows Live Local powered by Virtual Earth beta and includes bird's-eye view imagery from Pictometry International Corp. Microsoft introduced the revamped site. The imagery, at this point, covers 11 US cities and a few counties.

World's first GPS radio for second civil signal L2C

Accord Software and Systems Pvt Ltd, Bangalore, has created world's first GPS Radio for Second Civil Signal L2C. The United States' first GPS 2R-M1 satellite SVN 53/ PRN 17 capable of transmitting civilian signal on L2 carrier (L2C) started beaming L2C signal starting from December 16, 2005. Within days Accord announces world's first GPS L2C receiver front-end, capable of capturing and processing GPS L2C signal for research and development.

SiRFstarIII featured in navigation product

SiRF Technology Holdings, Inc has revealed that its flagship SiRFstarIII(TM) GPS technology is at the heart of TomTom's RIDER, a high performance portable navigation system specifically designed for use on motorcycles and scooters.

TomTom is a leading provider of personal navigation products and services to the US and European consumer markets.

MapInfo launches StreetPro China and Vietnam

MapInfo Corporation recently announced the launch of two premier StreetPro products, the People's Republic of China and Vietnam.

StreetPro is a comprehensive digital database of road networks and points of interest, providing users with a flexible, multipurpose foundation for location-intelligent business initiatives including site selection, infrastructure management, customer mapping and resource visualisation. *www.mapinfo.com*

Applanix releases POSPac AIR 4.3

Applanix recently announced the release of POSPac AIR 4.3, the latest update to its airborne data post-processing software. Exclusively developed for the aerial survey and remote sensing industry, the customized software incorporates a series of application-specific tools for systems using the company's POS AV (Position and Orientation System, Airborne Vehicles) Direct Georeferencing technology. Application-specific toolsets include Photogrammetry Tools for system calibration and quality control of Direct Georeferencing for frame cameras, DSS Tools for mission management and image development of DSS imagery, and SAR Processing Tools for use with SAR. *www.applanix.com*

$24 Million ClearView Contract to DigitalGlobe

DigitalGlobe has been awarded a $24 million satellite imagery capacity contract modification by the National Geospatial-Intelligence Agency (NGA). This ClearView contract enables the NGA to acquire additional commercial imagery from DigitalGlobe's QuickBird satellite.

Hemisphere reaches auto-steering sales milestone

Hemisphere GPS announced that it has reached a sales milestone by selling more than 2,000 of its Outback(TM) eDrive and Satloc GPSteer automated steering systems for tractors and other self-propelled agricultural equipment. Hemisphere introduced its two auto-steering products in North America in early 2004, and introduced them in South America, Europe and Australia during 2005.

Bentley Systems acquires RAM International

Bentley Systems acquires RAM international LLC, a provider of structural engineering software for building structures made from all major materials, including steel and concrete. RAM offerings include products for engineering modeling, analysis, and design.

eSpatial and PCI Geomatics enter partnership

eSpatial and PCI Geomatics have announced the signing of a strategic technology partnership. The alliance will combine eSpatial's iSMART Geospatial platform with Geomatica, PCI's image management products and solutions software suite, to provide an integrated environment for GeoSpatial solutions delivery. Both companies are currently working on an integration of their technologies, particularly PCI's advanced MappingCentre, an automated image processing and mapping delivery system, and eSpatial's iSMART GeoPortal. *www.pcigeomatics.com*

ESRI becomes Earth Science Information Partner

ESRI has been accepted as a partner of the Federation of Earth Science Information Partners (the Federation). The Federation is a network of researchers and associated groups that collect, interpret, and develop applications for satellite-generated earth observation information.

Avineon expands operations in India

Avineon officially announced the opening of a new state-of-the-art facility in Hyderabad, India for the company's India-based subsidiary, Avineon India Private Ltd. (AIPL). To accommodate continued rapid growth, the company has opened a new 20,000 square foot facility to house production for Avineon's IT and Geospatial Services Divisions (GSD) with capacity for more than 200 employees.

One million vehicles with Embedded Navigation Systems

NAVTEQ announced that for the first time since the introduction of in-vehicle navigation in North America, annual sales of embedded navigation systems exceeded one million units. Based on customer sales data from January 2005 through October 2005, approximately one million vehicles were sold with factory-installed navigation systems, representing growth of more than 40% over recorded sales from the same time period in 2004. Over 90% of car models offering navigation systems in North America use NAVTEQ(R) maps.

SatNav offers solution to BPOs in India

With the Business Process Outsourcing industry concerned over transport safety in the wake of the rape and murder of a woman employee by a driver in Bangalore in India, an IT products company in Banagalore has offered a solution. SatNav's Transport Logistic System (TLS) optimises the transport logistics facility and also helps companies cut their transportation costs by 10-15 percent. TLS covers computation of the number of cabs required for a shift, optimisation of time and distance travelled and display of best routes with driving directions for each cab.

Taiwan ER Mapper's Image Web Server

The Department of Land Administration, Ministry of Interior, Taiwan has selected ER Mapper's Image Web Server to distribute large volumes of air and satellite imagery within a land information/planning portal.

Image Web Server is an enterprise solution for serving and integrating large volumes of image data. The portal will service the needs of planners, the general public, as well as other government departments. Image Web Server was integrated with the Ministry's existing web GIS server, Autodesk's MapGuide, by local systems integrator Geoinfor. In this configuration, the MapGuide server processes all GIS requests, with Image Web Server responsible for serving all the imagery. *www.ermapper.com*

Intergraph's Z/I Imaging DMC selected by AAMHatch

Intergraph Corporation has announced AAMHatch has selected Intergraph's Z/I Imaging DMC (Digital Mapping Camera) to streamline its aerial imaging, mapping and remote sensing operations. The DMC delivers both large-scale and small-scale images with unmatched accuracy and speed, leveraging some of the most advanced digital imagery technology available. AAMHatch will go into production with its Intergraph DMC in early 2006, providing both small and large-scale digital images to customers. *www.intergraph.com*

Korea to establish satellite data center

Korea will establish a global navigational data center. The center will be linked to a global system of satellite tracking stations called IGS. The Korea Astronomy and Space Science Institute has said it has won a bid to establish the data center in Daejeon, southwest of Seoul. The center will collect data from more than 350 navigational satellite observatories worldwide and relay it to users. Korea hopes the new center will become a satellite navigation hub for Asia. *http://english.chosun.com*

Ordnance Survey welcomes partner for GPS network

The first public service based on Ordnance Survey's national network of GPS base stations has been announced. Great Britain's mapping agency has developed the network to support its own field staff. Now Leica Geosystems is the first organisation to announce a publicly available GPS correction service derived from it. The commercialisation of the network reflects growing demand for a wider choice of positioning applications among high-accuracy GPS users such as surveyors, engineers and utility companies. *www.ordnancesurvey.co.uk/gps*

Car navigation application in Malaysia

Navitech Sdn Bhd has been restructured to promote and market Car Navigation product in Malaysia and Singapore as it core business. Navitech has signed a Collaboration Agreement with Guidetek of Taiwan and MappointAsia Malaysia to package application software, map data and hardware for the in-car and after-market Car Navigation business. Guidetek, a subsidiary of Holux Technology Inc of Taiwan, supplies state of the art hardware to Navitech. This includes dedicated portable unit, portable PDA unit, in-car unit as well as other stand along GPS units. MappointAsia Malaysia supplies comprehensive and updated map data. Initially, the map data covers the Major Road Net Work of west Malaysia and street level road network of Klang Valley that includes Wilayah Persekutuan, Petaling Jaya, Subang Jaya, Shah Alam, Klang, Cyberjaya, Purtrajaya and KLIA. *www.navitech.com.my*

MTNL launches map-based location service

Mahanagar Telephone Nigam Limited in India has launched the first map-based location services, 'Maps and Directions', on its GPRS network. It offers location search, maps and directions to MTNL's GPRS users. The service has a nation-wide coverage, connecting more than 160 cities and six metros extensively. 'Maps and Direction' service has been offered in association with MapMyIndia. With a powerful array of features like eCity, eTrips and eLocator, users can quickly search and reach their destination with exhaustive database of over a million of points of interest and full colour interactive maps. eCity offers extensive entertainment options and emergency services whereas eLocation displays corresponding location map, customised directions and other contact information. Etrips allows its users to find directions, distances and road maps between all major cities of India. It also provides map and information about tourist destinations in the country. As of now the user has to select his current location through a guided search and specify his points of interest, but in the near future, MTNL plans to enhance the service to save customers from the hassle of selecting steps and location. Future offerings with MapMyIndia include a real-time online tracking system that would track registered mobile numbers on both GPRS mobile phones and internet. *http://www.efytimes.com*

GPS to empower Mumbai police in India

The Mumbai police force will soon be equipped with the GIS and GPS. A Rs 6-crore proposal to this effect was cleared by the Home Ministry. Soon, police control rooms will be fitted with GIS and 300 police vehicles with GPS equipment. Once the control room gets a call, in a matter of three to five seconds, they can trace the call to a specific location. They will know the location of the nearest patrolling vehicle and get information like traffic congestion on the street. It will help the force in rescuing people and in nabbing getaway vehicles. While the main police control room will be equipped with 25 computer terminals with GIS, the four regional control rooms and the traffic control room will have five such terminals. In the first phase, they will equip 300 vehicles with GPS. In the second phase, 150 more vehicles will have the feature. *http://cities.expressindia.com*

GPS to clear garbage in Vijayawada

GPS will be installed in 59 vehicles of the Vijayawada Municipal Corporation in India. It will ensure that the drivers do not cheat by skipping routes. All tankers, tippers, dumper plates in the vehicle depots will be equipped with GPS shortly. GPS provides specially coded satellite signals that can be processed in a receiver. Sitting in the VMC office, one can monitor the movement of the vehicle, the routes and the distance covered. GIS will record all the routes covered by the vehicles, the distance they cover and the time. *http://www.newindpress.com*


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NAVTEQ offers maps of South Korea

NAVTEQ is offering a map with navigable coverage throughout South Korea through its wholly owned subsidiary, PMI. The South Korea map covers 100% of the population (approximately 48 million people) of South Korea, and is a fully navigable roadway map enabling door-to-door route calculations and turn-by-turn route guidance throughout the country.

Detailed road network information, such as one-way streets and turn restrictions, is linked to the map, which provides NAVTEQ customers with additional information to create the most efficient routes for their solutions. The map also includes more than 400,000 Points of Interest in more than 290 categories and subcategories, cartographic features (such as parks, waterways and woodlands) and more than 7 million listings from the KoreaTelecom business directory. *www.prnewswire.com*

GIS ward maps of Dhaka being prepared

GIS ward maps of Dhaka City Corporation in Bangladesh are being made. GIS maps for 59 wards in Dhaka have been completed while 16 maps are under planning processing.

Rest of the 15 would be completed by next fiscal year. In the GIS ward maps, holding number of every residential house and commercial building and the location of owners of the houses are included. Therefore, location of all educational institutions, markets, mosques, temples, churches, mazars, banks, hospitals, clinics, community centres, important government and private offices, bridges, culverts, graveyards, roads, coaching centres, dustbins and slums are also included in the ward maps.

Houses under construction and completed houses along with heights of the buildings are also found in the map. *www.nation.ittefaq.com*

Qatar atlas being prepared for 2005

The GIS unit of the Planning Council's Statistical Department in Qatar has been awarded a project to produce an atlas of Qatar for 2005. It will be the second edition of the socio-economic atlas of Qatar, which was first published by the department in 2000. The atlas will primarily focus on analysing socio-economic data, mainly available through censuses and surveys conducted by the department, the report said.

However, a significant portion will be devoted to topographical maps, administrative set-up, and environmental conditions. It will also highlight Qatar's infrastructure, trade, economy and industry. The atlas will be produced using GIS to process and produce the maps. This will be first published in print form and subsequently converted into an interactive CD. The one-year project is likely to be ready by the end of next year. *www.gulf-times.com*

GIS boom in India: At a glance

- Union Science and Technology Minister Kapil Sibal has released a series of new earthquake hazard maps for the city of Delhi, India providing area-wise details of the risks that the city could face in the event of an earthquake. Three regions face the highest risk: the trans-Yamuna area, West Delhi and Chhattarpur area.
- Dakshina Kannada district police in the Indian state of Karnataka are set to adopt 'GIS' to monitor security arrangements in the local zilla and taluk panchayat elections to be held this week. The digital map of the district available with Natural Resource Development and Management Society (NRDMS) centre was integrated with the information related to police security scheme with the help of Arc view software.
- A GIS aided road map will be introduced in Kerala in India for upgrading road network to international standards. The ''Road Information Management system'' (RIMS), expected to be completed in January next year, would help in upgrading and building new roads in a time bound manner. Once the mapping is complete the Public Works Department in each district will be equipped with all the information regarding roads by July 2006.
- The World Health Organisation has begun a project to monitor the level of heavy metals in 400 coastal water bodies in Tamil Nadu in India fearing the tsunami last year may have deposited these substances along the coast. The monitoring is taking place in the coastal water bodies such as wells and deep and shallow tube wells. The water bodies have been identified using GIS. Tests are being done every alternate month for heavy metals such as Cadmium, Lead and Titanium.
- The Municipal Corporation of Hyderabad (MCH) in India will soon introduce an Automatic Vehicle Tracking System to ensure better sanitation in the city. Under the plan, the movement of garbage-lifting vehicles will be monitored with GIS so that anomalies in the process can be avoided and there are no complaints of garbage not being lifted.
- The Municipal Corporation in Chandigarh in India are exploring the possibility of videographing commercial sites in the city for public benefit. It can be done by attaching video clippings of the commercial sites with a GIS. If the proposal is finalised the Union Territory will consider implementation of the system for residential property.

ISRO to launch 10 satellites in four years

The Indian Space Research Organization is planning to launch 10-12 satellites in the coming four years, Minister of State in the Prime Minister's Office Prithviraj Chavan informed the Rajya Sabha. The satellites which have been approved by the Government are- communication satellites INSAT-4A, 4B and 4C, communication satellites GSAT-4 and GSAT-5, advanced satellite for cartographic mapping applications Cartosat-2, microwave remote sensing satellite with all weather capability radar imaging satellite, satellite for oceanography studies and services Oceansat-2. Remote Sensing satellite for natural resources management applications (Resourcesat-2), development and qualification of re-entry and recovery technologies for future space transportation system and conduct of Micro-Gravity Research (SRE-1and 2), advanced satellite for meteorological observations (INSAT-3D), Indo-French Joint mission for tropical climatic research (Megha-Tropiques) are some of the others.

ANTRIX certifies Leica and ERDAS as cartosat ready

Leica Geosystems Geospatial Imaging and ERDAS India Pvt. Ltd., announce the successful development, integration and testing of CartoSat Sensor Model within ERDAS IMAGINE and Leica Photogrammetry Suite. Antrix entered into the agreement with ERDAS India Pvt. Ltd. to develop an interface facilitating integration of CARTOSAT-1 satellite data products with ERDAS IMAGINE and Leica Photogrammetry Suite. On 9th December, 2005 ANTRIX officially certified ERDAS IMAGINE and Leica Photogrammetry Suite as Cartosat ready and confirm to the specifications defined Antrix Corporation Limited. ERDAS IMAGINE and Leica Photogrammetry Suite are certified Cartosat Product Import and Image Processing, Single Image Triangulation, Stereo Pair Triangulation, Block Triangulation for Stereo Imagery and Digital Topographical/Feature Mapping.

Indian state launches survey operations

The Indian state Andhra Pradesh's Chief minister Y S Rajasekhara Reddy recently launched survey operations for Nizamabad district under the Integrated Land Information System (ILIS), using aerial photogrammetry and electronic total stations technology. The original survey operation was conducted in Nizamabad in 1897. National Remote Sensing Agency (NRSA) would fly aircraft fitted with sophisticated cameras over Nizamabad district. Photo data generated would be processed and prints of appropriate size would be carried out for ground verification of boundaries with farmers. The aerial survey of the entire Nizamabad district would be completed in the next 4 to 6 weeks. The field work was expected to go on upto November 2006. *http://news.webindia123.com*

Cabinet approves India-Ukraine space agreement

The Union Cabinet in India has approved the signing of a Framework Agreement between India and Ukraine for cooperation in peaceful uses of outer space and space research. The agreement, which was signed in June, last year in the presence of Presidents of the two countries, will remain in force for ten years after which it will automatically extend for another ten-year term. The agreement envisages cooperation between the two countries in basic space science, meteorology, remote sensing, geo-physics and space, radio sciences, aeronomy, space bio-technology, ionosphere and space plasma. *http://www.newkerala.com*

Russian firm to sign satellite launch deal with Indonesia

A Russian satellite firm expects to receive the affirmation to use Indonesia's Biak Island as its launch pad next month. It has been reported that Russia and Indonesia have already finalized a government-to-government agreement on cooperation in exploration of outer space for business purposes. It is expected that the pact will be signed next month, paving the way for the use of Biak, in Papua province, as a satellite launch base. *http://www.bangkokpost.com*

Bio-monitoring of China's water diversion program

China has recently applied remote sensing technology to biological environment monitoring in a mammoth state water diversion program. The remote sensing bio-monitoring of the middle route of the huge south to north water diversion program has recently passed appraisal by experts with the Ministry of Science and Technology. The project employs remote sensing systems. The systems monitor soil erosion, landsides and embankment collapses, changes in river channels, water quality and plant coverage in the water source area of the Danjiangkou reservoir, the lower- and middle-reach of Hanjiang River valley and the intake area of the water diversion program's middle route. *http://english.people.com.cn*

NASA satellites yield Antarctic maps

Scientists using satellite data have created detailed maps of the vast snow-covered Antarctic continent. Researchers can now decipher the intricate history of ice movements in the just-released "Mosaic of Antarctica," which uses images from the Moderate Resolution Imaging Spectrometer onboard NASA's Terra and Aqua satellites. The map is the result of a partnership between NASA's Goddard Space Flight Center, Greenbelt, Md.; the University of Colorado's National Snow and Ice Data Center (NSIDC), Boulder; and the University of New Hampshire, Durham. *www.spaceref.com*

"India should have its own positioning satellite system"

says K Ramalingam, Chairman, Airports Authority of India (AAI) while discussing the mandate and activities of AAI related to GPS

What is mandate of Airports Authority of India (AAI)?

As designated by International Civil Aviation Organisation (ICAO), AAI is mandated to control and manage the Indian airspace extending beyond the territorial limits of the country, i.e., land airspace of 1.05 million NM2 and oceanic airspace of 1.75 million NM2. [NM Nautical Miles]

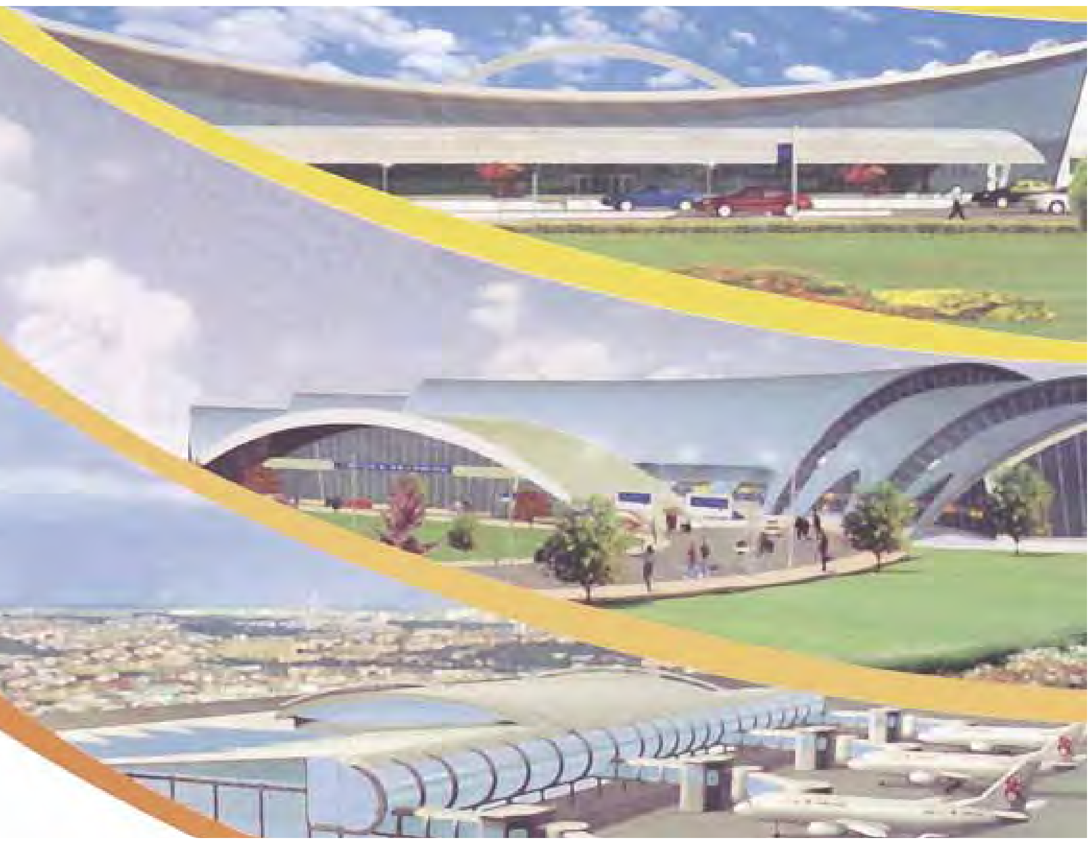
What role AAI is playing in GAGAN?

Yes, AAI is committed to provide SBAS over Indian airspace as per Communication, Navigation, Surveillance / Air traffic Management (CNS/ATM) plan envisaged by ICAO. As you may be aware that Indian airspace is falling between coverage area of European Geo-stationary Navigation Overlay System (EGNOS) on the West and Multi Functional Transport Satellites (MTSAT) Satellite - Based Augmentation System (MSAS) (Japan) on the East but definitely not in the service area of both. It means that no Global Navigation Satellite System (GNSS) integrity-monitoring signal will be available over Indian airspace. To bridge the gap between the coverage areas of EGNOS & MSAS and to facilitate seamless navigation to the aircraft from West-East and vice-versa, therefore GAGAN is a requirement.

As you know that GAGAN is a technology driven project and is still evolving. It has been envisaged that Department of Space (DOS) / Indian Space Research Organisation (ISRO) will be in the right position to drive the project whereas AAI will provide the requisite financial, technical manpower and all the other supplementary support for the project.

In what activities of AAI Global Positioning System (GPS) are used at present?

At present AAI is using GPS constellation for airport cartography application but in future GPS will be used for surveillance and navigation purpose.



AAI is planning to conduct Automatic Dependent Surveillance –Broadcast (ADS-B) trials over Bay of Bengal and Arabian Sea where installation of Radar is not possible; therefore surveillance becomes difficult for en-route aircrafts. In this area GPS plays an important role as position locator in user-friendly environment. The position of the aircraft will be displayed on ground display console, which will help the Air Traffic Control officers (ATCO's) to monitor the progress of the flight.

Secondly GPS will be used as core constellation of GAGAN. This core constellation will be augmented with Geo-Stationary Earth Orbiting Satellite (GEOS) i.e.

GSAT-4, which will carry the required navigation payload for GAGAN.

Thirdly GPS constellation is being used in Airport cartography for preparing Grid maps, zoning map etc.

Therefore AAI is /will be using the GPS constellation in the major functions of CNS/ATM activities.

What is the future plans of AAI regarding GPS?

As such GPS core constellation belongs to Department of Defense (DOD) US. Now US Government has plan to modernize the GPS signal by introducing new frequency i.e. L5 which will be delivering more Carrier to Noise ratio power and less affected by Ionosphere as compared to the L1 and L2 frequencies. ISRO has made provision of L5 frequency in GSAT-4 satellite payload, planned to be launched in the last quarter of 2006.

What are visible impacts of the introduction of GPS in AAI?

As explained earlier, in the field of surveillance, we will able to monitor the entire Indian airspace under user-friendly environment. This will provide great help to AAI for safety of aircraft and reducing the congestion in the Indian air space. In this environment new concept of RNAV (Area Navigation) can also be implemented.

In the field of navigation, it will provide seamless navigation over Indian airspace. RNAV can be further redefined with less separation and will help in reducing the airspace congestion. GAGAN will help further to dismantle terrestrial en-route nav-aids.

GAGAN signal will be available to the all Indian airports for navigation as well as precision approach landing. Only AAI has to develop the landing procedure with GAGAN parameters.

It will further improve the accuracy of grid map and charts prepared by AAI based on the survey done by department of cartography (AAI).

How do you see the dependence of India on US based GPS system?

As GPS system belongs to DOD US and they took more than 20 year to bring this technology and provided services to the civil users free of cost. India is fourth country, which has decided to have own augmentation system based on GPS system. One fear will be always if US withdraws the GPS signal due some reason, the GAGAN system will collapse. So I feel that India should have its own positioning satellite system like GPS.

How do you see the developments regarding the development pertaining to Galileo?

I understand Government of India as recently signed MOU with European Union (EU) to participate in the Galileo Program. EU is implementing Galileo. The core system will have 30 satellites and is likely to be available by 2008 as per the existing schedule. Let's see how does it go.

What is the Government of India's policy towards GLONASS?

GLONASS is owned and maintained by Russian Federation. The system is depleted and number of serviceable satellites in orbit has depleted very much. Government, I understand, is taking note of it.

Shri Kannayan Ramalingam is the Chairman of Airport Authority of India (AAI) entrusted with, inter alia, the control and management of Indian air space providing communication, navigational and surveillance aids to air traffic operating to and from Indian Airports, AAI manages 126 airports in the country. Born in Cuddalore District of Tamil Nadu, Shri Ramalingam studied in Chennai and did M.Tech from IIT in Electrical Engineering. He obtained postgraduate degree in management (MBA) from AIMA with specialization in information technology. He also possesses a diploma in administrative & Labour Laws from Annamali University.

Shri Ramalingam, 56, is on the Board of Directors of the number of reputed organizations like Indian Airlines and Air India. He has been nominated for various high level Government and professional committees. His international assignments included: -

- Vice President, Airport Council International (ACI) - Asia.
- Member of World Governing Council of ACI.
- Member of ICAO Global Navigational Satellite System Panel and Navigation System Panel for preparation of standard and recommended practices.
- Executive Committee Member of Civil Air Navigational Services Organization (CANSO), Netherlands.

Shri Ramalingam is an expert in the field of Communication, Navigational and Surveillance/ Air Traffic Management (CNS/ ATM). He has planned and executed installation of a number of CNS systems. He also renders technical advice to various national and international bodies in various projects in the field of civil aviation. Anna University conferred Honorary Doctorate for his contribution to the growth of civil aviation in India.

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Advances in GPS/GNSS data processing

Till the year 2015 there will be a constant and radical change in the existing GNSS data processing techniques

SRIDEVI JADE

GNSS is a global navigation satellite system comprising of network of satellites that transmit ranging signals used for positioning and navigation anywhere around the globe; on land, in the air or at sea. The US Global Positioning System (GPS/Navstar GPS), the Russian Global Navigation Satellite System (GLONASS) and the upcoming European GALILEO system, Data communications satellites with navigation payloads and Augmentation systems are all part of GNSS.

IGS the official website of voluntary federation of more than 200 worldwide agencies that pool resources and permanent GPS station data to generate precise products formerly known as International GPS service has now been renamed as International GNSS service. The conventional GPS data processing techniques are also being modified to incorporate the new satellite systems of GNSS which pose major challenges of different satellite signals, different reference frames and different time scales to be incorporated for combined processing.

Most of the academic and commercial existing data processing softwares process the code and phase pseudo ranges obtained from L1 and L2 satellite signals of Navstar GPS / GPS to obtain the positions. Most of the world wide users are currently dependent on Navstar GPS technology which is owned, operated and controlled entirely by one country, the United States. Bernese 4.2 GPS software has the capability to process the satellite signals of both Navstar and Glonass GPS systems and combining them to give the precise and improved positions. Proposed Navstar GPS modernisation has thrown new challenges with two new satellite civil signals L2C, and L5 which will be available for initial operational capability by 2010 and for full operational capability by approximately 2013. The current NAVSTAR GPS data processing software's now should be able to absorb these new civil signals for positioning.

The world wide GNSS network of tracking systems now recognises the demand for real time processing of 1 Hz GNSS data for early warning and rapid damage assessment. Potential user groups who would benefit from the availability of GNSS data and products include from among others; geodetic agencies mandated to provide access to a globally consistent reference frame for all position applications, precision navigation users (LEO), agencies involved in natural hazards monitoring, prediction, warning and response, structural engineering monitoring, near/real-time atmospheric monitoring for weather prediction, real-time earthquake seismology (simultaneously with seismological analysis), and time transfer and dissemination. The IGS Real-time Working Group (RTWG) is presently assessing and addressing issues that pertain to the IGS developing real-time infrastructure and processes..

GNSS data processing

Currently, there are only two satellite navigation systems in operation, the Global Positioning System (GPS/Navstar GPS), and the Russian equivalent GLONASS system. Galileo satellite navigation system due to be launched by European Union in 2006, will be made available to public by 2010. Table 1 gives the comparison of present and future Global navigation satellite systems and Table 2 gives the present and future services of GNSS. In addition to the these main GNSS infrastructures, Quasi-Zenith Satellite System of Japan is under development (QZSS), with three satellites placed in a special orbit that maximizes coverage over Japan and Beidou satellite navigation and positioning system of china consisting of two geosynchronous satellites to complement the existing GNSS systems. Space Based Augmentation Systems (SBAS) and Ground-Based Augmentation Systems (GBAS) have been built (or are being deployed) by the United States, Europe, India, Japan, Australia and China to augment the existing GNSS.

Currently majority of GPS users worldwide are using only GPS/ Navstar GPS for their application and the major scientific GPS data processing software only process the data form Navstar satellites. Only exception to this is the BERNESE 4.2 software which has the capability to combine the GPS and GLONASS satellite data.

The success story of BERNESE group of being able to combine the two different satellite navigation systems with different satellite signals, reference frames and time scales gives confidence for the inclusion of Galileo and future satellite systems. GNSS data processing will now become a cost-effective and precise approach of high-accuracy software simulations which are reproducible and totally controlled by the user, and parameters can be changed individually if necessary for an in-depth analysis of the combing the various GNSS systems. The immediate need of the GPS community is to be able to include the new satellite signals L2C and L5 of Navstar GPS in to the data processing software's as it effects majority of the GPS users worldwide.

Real time GNSS data processing

Many very demanding applications and systems now require GPS raw data and products in real time with greatly reduced delays which underlines a need for the availability of real time data and products required for the real time GNSS data processing. The GPS Earth Observation Network System (GEONET) in Japan consisting of 1200 GPS stations with an average spacing of about 20 km has been successful in real-time observations and analysis. For real time analysis GPS sites should sample data at 1 Hz and transmit the measurements in real time to the analysis center which are then processed for instantaneous coordinates and baseline components which are then adjusted with absolute ITRF coordinates of the stations sufficiently remote from the region of analysis. Instantaneous coordinate accuracy is about 1-2 cm in the horizontal and 10-20 cm in the vertical, compared to the known ITRF coordinates of the stations. Real time instantaneous (horizontal) position changes detected by a dense GPS network (like GEONET) could be used as part of an early warning system for mitigating natural hazards. To fully serve the multi-disciplinary scientific user community the IGS real-time working group (RTWG) is working towards enhancing its standards for infrastructure, data and product availability. The primary products of such a system will be GPS/GNSS station data, satellite orbits and clocks, made available to the user by Internet and other economical and available streaming technologies. This will also ensure a standardization of the real time networks and would cater to multiple user community as non-IGS near/real time networks are emerging without standards. Real time water vapor estimation (SuomiNet and GeoNET) is already been integrated in to Weather Research and Forecasting (WRF) model which is a new generation advanced mesoscale (10km-1km) model for both operational numerical weather prediction (NWP). Improved rainfall forecast due to assimilation of GPS Precipitable Water Vapor were observed for several hours into the forecast. Similarly, Ionospheric perturbations associated with atmospheric disturbances, such as earthquakes, large explosions, or rocket launches have been detected through filtering of dual-

Table 1: Main features of GNSS

	GPS/Navstar GPS	GLONASS	GALILEO
Number of satellites	24 (fully operational)	24 (16 operational)	30 (to be launched)
Orbital height	20,200 km	19,100 km	23,616 km
Orbital plane inclination	55°	64.8°	56°
Orbital planes	6, spaced by 60°	3, spaced by 120°	3, not uniformly space
Satellites per orbital plane	6, unequally spaced	8, equally placed	10, unequally spaced
Revolution period and ground track repeatability	11hr 58min; every sidereal day	11hr 16 min; every eight sidereal day	14hr
Satellite separation technique	CDMA	FDMA	CDMA
Satellite clock correction	Clock offset; frequency offset; frequency rate	Clock offset; Frequency offset	
UTC correction	UTC(USNO)	UTC(SU)	UTC(GST)
Reference frame	WGS 84	PZ 90	GTRF
Carrier Frequency	L1: 1575.42 MHz L2: 1227.60 MHz	L1: 1602… 1615.5 MHz L2: 1246… 1256.5 MHz for channel number 0 to 24	E2-L1-E1: 1559-1592 MHz E5a: 1164-1215 MHz E5b: 1164-1215 MHz E6 :1215-1300 MHz
Orbital parameters	Every 60min, modified Keplerian elements	Every 30 min, satellite position, satellite velocity, satellite acceleration	

Table 2 Current and future services of GNSS

Services	GPS		GLONASS		GALILEO	
	2005	2015	2005	2015	2005	2015
Basic positioning (unencrypted)	SPS L1 CA	SPS L1CA L2C L5	SP L1	SP L1 L2 3rd signal		OS L1 E5a E5a
Integrity/safety (unencrypted)				Integrity message		SoL L1 E5a E5b
Commercial/value-added(encrypted)						CS E6
Security/military (unencrypted)	PPS L1 P(Y) L2 P(Y)	PPS L1 P(Y) L2 P(Y) L1 M L2 M	HP L1 L2	HP L1 L2 unknown		PRS L1 E6

SPS- standard positioning service, PPS- precise positioning service, SP- standard precision, HP- high precision, OS- open service, SoL- safety of life service, CS- commercial service, PRS- public regulated service

frequency real time GPS phase data. It is important to track the ionosphere which is a dynamic region capable of adversely impacting a variety of space-based systems.

Future

Recent advances highlight the huge potential that exists for future navigation and positioning applications. The vast majority of the world will be users of these existing systems which pose a whole lot of questions like: Which system or systems should a country use? Which combination of systems? What are the benefits and respective merits of those systems? What kind of integration should be followed? What kind of real time GNSS network should be used? Which data processing software to use? Etc... There is no simple answer to these questions, as the best solution will undoubtedly depend on the application, which has its own requirements in terms of accuracy, reliability, robustness, cost, and other application-specific criteria. What can be provided, however, is a means whereby parameters that describe these performance requirements can be computed. Software needs to be developed to conduct a qualitative assessment of the performance characteristics of future GNSS infrastructure.

From now till the year 2015 there will be a constant and radical change in the existing GNSS data processing techniques though the underlying principles will not change much. As a user , one needs to keep abreast with all the latest developments in this field as the current processing software's will be adopting to the new satellite signals, new satellite systems , different reference frames and real time availability of the data and the products

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An open GNSS receiver platform architecture

The aim of the project is to develop a platform for supporting GNSS research and provide an accessible IP block

PETER MUMFORD, KEVIN PARKINSON AND FRANK ENGEL

In early 2004 a plan was hatched to develop a Global Navigation Satellite System (GNSS) receiver based around Field Programmable Gate Array (FPGA) technology as a platform to support research in this field. A joint project was set up between the School of Surveying and Spatial Information Systems (SISS) at the University of New South Wales and the National ICT Australia (NICTA), and soon after a small team was established. The team consisted of Kevin Parkinson, a post-graduate student at SISS with experience in FPGA and circuit board design, Frank Engel, a researcher with NICTA with software, Real Time Operating Systems (RTOS) and VHDL design knowledge and me, Peter Mumford from the SISS GNSS research group. At the end of the project we hoped to have an L1 GPS receiver running on a custom circuit board with the baseband processor and navigation solution processor running on an FPGA chip. The project is coming to an end now, and in this article, I will describe our design path, what has been achieved to date and then some potential research areas, but first a little background.

Background

The Global Positioning System (GPS) is the only fully operational GNSS, but with the Russian Federation's Glonass System being refurbished (with the help of India) and the European's Galileo, there may be three operational systems by 2008. In addition, there are Space Based Augmentation Systems (SBAS), Wide Area Augmentation Systems (WAAS), Japan's Quasi-Zenith Satellite System (QZSS) and other signals that will become, or are already available to GNSS receivers. To enable research with so many new signals, a flexible platform is required that can respond to the requirements of the signals without waiting for Application Specific Integrated Circuit (ASIC) chips to become available. FPGA technology is a natural choice to host the baseband and application processors due to their inherent design flexibility, the maturity of the chips and development tools, good performance and reasonable price. Getting flexibility in the Radio Frequency (RF) front end is a bit more difficult.

In the near to medium-term future the market for satellite navigation technology is expected to continue to experience major growth (Canalys, 2004). The ability to integrate GNSS functionality into a device by hosting the baseband processor on an existing FPGA chip may provide an opportunity to lower costs, as well as providing a degree of future-proofing. In addition, the relative ease of creating special GNSS attributes in an FPGA may lead to novel applications or solve particular problems.

The aim of the project is to develop a platform for supporting GNSS research and provide an accessible IP block. To explain the content of this platform, I will first describe the three major components of a generic GNSS receiver, they are:

1) The RF front-end for receiving GNSS signals and converting it down into an Intermediate Frequency (IF) sampled baseband signal.
2) The baseband processor (sometimes called the correlator block) that provides data for acquiring and tracking the signal, and measurements for calculating the position/time solution.
3) A micro-processor that runs software to control the baseband processor, and compute and communicate the position/time solution.

The first component generally requires special circuitry, although single chip GPS receivers have recently become available. Components 2 and 3 typically reside in the same ASIC, but can likewise be hosted in the one FPGA chip as FPGA vendors offer CPU cores (as well as memory and DSP capabilities) integrated into the chips.

The Mitel GPS Architect

The Mitel GPS Architect (sometimes referred to as Orion) software was designed to help Mitel sell GPS chips by providing reference software in the form of a development kit. The original software runs on an ARM60 processor, with a Zarlink GP2021 (Zarlink, 2001) baseband processor and GP2010 or GP2015 RF front end. In 2003 I ported the code to the Sigtec MG5001 GPS receiver. This receiver has a Zarlink GP4020 chip with an ARM7 core and GP2015 RF front end. The GP4020 has the same correlator design as the GP2021. It seemed a natural progression to port the GPS Architect to Altera's NiosII processor.

Altera Tools

The FPGA vendor Altera provides a logic development tool called "Quartus" and a software development

Fig 1. The Superstar-Nios "hack"

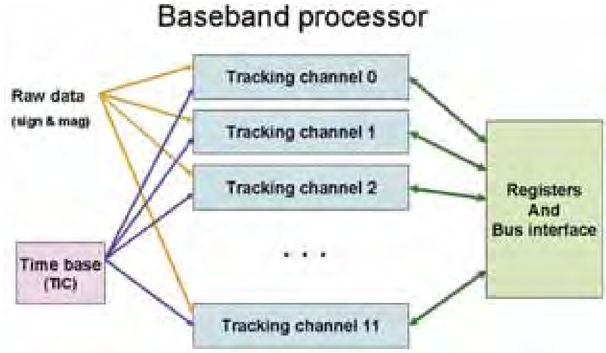

Fig 2. Generic bseband processor

tool, the "NiosII IDE" for the NiosII soft-core processor. Quartus contains the "SOPC Builder" used for generating Nios core FPGA design files. The NiosII development tools provide a Hardware Abstraction Layer (HAL) and an Application Programming Interface (API) that incorporates the Newlib ANSI C embedded library. Altera has a range of development boards available, these are very convenient for getting projects up and running quickly. The Statix development board is used for the first task of this project.

Design Approach

The approach we have taken is to break the development process into three main tasks. These tasks are identified as "SuperStar_NIOS", "FPGA_baseband" and the "Custom GNSS Platform" and are described below.

SuperStar-NIOS

This first task involved porting the Mitel GPS Architect software to the NiosII processor. To set up the hardware for working on the port, we hacked into a Superstar receiver and removed the ARM60 and memory chips. We then connected the GP2021 address, data and control lines to a header onto an Altera Nios Development Board. Figure 1 shows what it looked like.

There are significant differences between the NiosII and ARM7 architectures and instruction sets, as well as differences in the development tools and embedded libraries. The main effort in porting the software concentrated around the RTOS, serial port communication and hardware initialization. The GPS Architect has a minimal RTOS closely integrated with the rest of the code. The task-switching core of this RTOS is coded in assembler, and this was completely rewritten for the NiosII processor. Some 'glue logic' was required to connect the Nios processor to the GP2021 baseband processor. After some debugging we obtained the correct position/time solution. However, the hardware arrangement was quite noisy, and the position solution revealed some evidence of this, however in most respects the receiver performed much like the Signav receiver running the GPS Architect.

FPGA_baseband

The second task was to develop a baseband processor design in VHDL logic. The Zarlink 2021 was used as an architectural model to get things rolling. The code was developed and functionally debugged with ModelSim. Once the design was complete a testbench was built to inject a sampled GPS signal into the design and look for correlation peaks. The sampled signal file consisted of a few milliseconds of sign and magnitude raw IF data generated by Data Fusion software. The simulation typically took several days to run, and we eventually found the correlation peaks we where looking for.

Custom GNSS platform

The third task was to develop a custom designed circuit board and then port the GPS Architect software to it. The board is shown in figure 4, it has an Altera CycloneII FPGA device and a Zarlink 2015 RF front-end. For IO there is an Ethernet port, two RS232 serial ports and a JTAG programming / debugging port. There is sram and flash memory as well as a configuration controller and serial flash. There are expansion headers, a real time clock, a three axis accelerometer, leds, switches and sma connectors.

The board was designed for very low noise to keep interference with the sensitive RF front end down. It can be seen in figure 5 that the IF output of the 2015 RF chip is free from interference spikes.

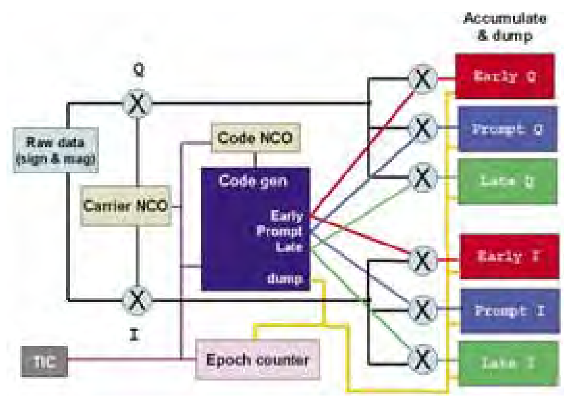

Fig 3. Tracking Channel

Fig 4. The 410 GPS development board.

A single channel baseband processor has been built on this board to test the correlation functions and tune the tracking loops. Correlation peaks have been obtained from signals injected from a Spirent GPS simulator. Figure 6 shows a correlation plot, on the x-axis is the code delay (in half-chips) over two carrier doppler bins, and on the y-axis is the correlation power.

Shortly, we will finish working on the tracking loops and then the GPS Architect is pretty much ready to run on the custom GNSS board. There will be a debugging and testing stage over the next few months, followed by the publishing of our results. We also have an improved baseband processor written in Verilog ready to replace the VHDL version.

The inflexibility of the RF front end was eluded to earlier in this article. The custom board has only an L1 (1575MHz) front end. Due to pass-band filtering and available chips, it is difficult to make a front end that covers more bands. Our solution was to provide a header and some sma clock connectors to allow a daughter board to be attached later for access to other signals. Daughter boards can be built to suite the Galileo and new GPS signals once the RF chips are available.

Further Development

Due to the configurable nature of FPGA's, there are many possibilities for research using this platform including:

- Baseband signal processing design: improved tracking in weak signal and multi-path environments.
- Investigating new signals.
- DSP search engine: for signal acquisition and tracking, particularly for weak signals.
- Develop the GPS Architect software for better performance or specific functionality.
- Replace the GPS Architect.
- Raw data collection and packaging for PC based soft receiver processing.
- Signal interference (jamming) detection.
- Ultra-tight INS integration.

Conclusion

The project is heading towards completion. We have the FPGA GNSS circuit board running a single channel baseband processor, tracking a GPS satellite. We have the GPS Architect software ready to run on the NiosII processor. We hope to complete testing and report our results in early 2006. We hope that our work will then be of value to the GNSS research community.

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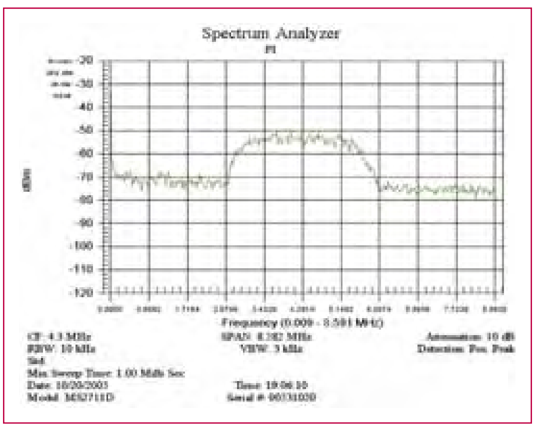

Fig 5. Frequency sweep of the IF output of the 2015 RF chip.

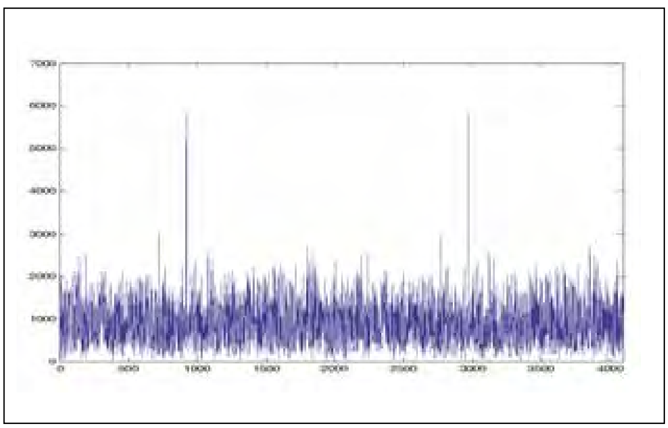

Fig 6. Correlation peaks

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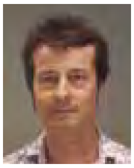

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Galileo update

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.

First Galileo satellite launched from Kazakhstan

The EU's first satellite of the Galileo navigation program has been launched from Kazakhstan. The 600 kg British built spacecraft, named "Giove A," took off from the Baikonur Cosmodrome on a Soyuz rocket early Wednesday morning (28 December 2005). The satellite is part of Galileo, the €3.4 billion system from which the EU is aiming to deploy a total of 30 satellites by 2010. The network will provide access to precise timing and location services delivered from space to the bloc's member states. The Galileo project aims to revolutionise industries including transport and will be used in maritime, rail and other navigation systems. According to reorts it will help the EU to set up a new air-traffic control system, allowing pilots to fly their own routes and altitudes. Giove A will test technologies needed for the other components of the project, like the in-orbit performance of two atomic clocks or radio frequencies assigned to Galileo within the International Telecommunications Union. Galileo is a joint project between the EU and the ESA. *http://euobserver.com*

Location of Galileo Programme facilities

The future Galileo Concessionaire has agreed the locations of the various facilities under its responsibility that are required for the successful deployment of the Galileo programme. According to this Agreement the Headquarters of the Galileo Concessionaire will be located in Toulouse, France. The Operations Company will be located in London, United Kingdom.The two Control Centres (Constellation and Mission) will be located in Germany and Italy as well as the two Performance Evaluation Centres supporting the concessionaire headquarters. Spain will host facilities that include redundancy for the Control Centres, and are related to Galileo safety critical applications.Furthermore, a new consortium of German companies will join the team, adding core competencies to the Concessionaire.

NovAtel Receives Galileo Safety of Life Receiver contract

NovAtel Inc has announced that it has been awarded a contract by CMC Electronics Inc., to undertake development of a Galileo Safety of Life (SoL) demonstrator receiver for the Canadian Space Agency (CSA). The value of this contract is CDN$500,000.

NovAtel will develop a new Galileo E5a/E5b receiver section for addition to the existing Galileo Test Receiver, which NovAtel had previously developed for the CSA under a Space Technology Development Program contract awarded in September 2004. A modified CMC Electronics CMA-3024 Global Navigation Satellite Sensor Unit airborne receiver will be integrated with the NovAtel engine.

Ellipsoidal heights and engineering applications

Research with real data proves they will work

MUNEENDRA KUMAR, PH.D.

As the GPS surveying techniques started showing promise of high accuracy geodetic positioning in the early 1990s, few "open-minded" geodesists realized the possibility of using ellipsoidal heights in place of orthometric heights. Many conceptual approaches were mentioned and proposed in various applications. However, Steinberg and Papo were the first to publish a paper entitled "Ellipsoidal Heights: The Future of Vertical Geodetic Control" *(GPS World, Vol. 9, No. 2, 1998)*. As could be expected, Petr Vanicek, a geodesy professor, was quick to downplay the proposed new "type" of vertical control *(GPS World, Vol. 9, No. 4, 1998)*. It seems that Steinberg and Papo did not "defend" their new proposal. Thus, in this paper, a review has been made to check and comment on Vanicek's example against the ellipsoidal heights, reference to orthometric islands, and issuance of a warning for non-dissemination of ellipsoidal heights to Canadian users.

Facts to note

The following geodetic facts are pointed for users to have better appreciation for the new approach:

1. As MSL is not an equipotential surface, it cannot be considered as a zero reference for orthometric heights and depths for all areas, land or ocean.
2. MSL has "slope" along coasts, both in E-W and N-S directions. Thus, a zero elevation does not necessarily coincide with MSL.
3. There are coastal points along Caspian Sea and Dead Sea, which have negative heights (-H) or are below "sea level".
4. Two points on a "level" surface can have "different" heights (H).

Observations on Vanicek's Opposition *(GPS World, Vol. 9, No. 4, 1998)*:

a. Warning for Non-dissemination of ellipsoidal heights (h) – It seems that this warning was issued based on old traditional usage and also on fear of mix up by the users. Instead, if a review and check had made of the new idea, the warning would not have been needed *(Coordinates, Vol. 1, No. 3, 2005)*.
b. Example of negative ellipsoidal heights along the coastline for an engineer, who wants to plan port facilities – Engineers have worked in the past and still work routinely with negative MSL heights along the North Sea in The Netherlands. Thus, the negative comment does not prove anything against the proposed use of ellipsoidal heights. Interestingly, the traditional geodesists accept negative MSL elevations along Caspian Sea and never question how a seacoast can be below "sea level"!
c. Orthometric Islands and chart datum – It is difficult to understand why this topic was brought out against the ellipsoid heights.

In a nutshell, first Prof. Vanicek should have been open to the proposal of two researchers, checked it with the real data, and then commented accordingly. He just chose to downplay his futuristic colleagues in old traditionalistic approach.

Checking real data sets

Here, the first step was to collect the real geodetic data, viz., "h, H, and N" (Note: The GPS surveyed heights "h" do not require any theoretical models and approximations). The data sets were obtained from the U.S. National Geodetic Survey (NGS) for eleven States, viz., Washington, California, Texas, Nevada, Colorado, New Mexico, Virginia, Tennessee, Georgia, New York, and Kansas. Here, the criteria was terrain variation from mountainous to flat plain and the area covered to have good geographical distributed over the country. For linear distances up to 3-5 km between two points, the differentials "Δh" and "ΔH" differed from each other by 1-3 cm. Thus, the important point to note is that the zero references for "h and H" are different, but the "Δh" and "ΔH" are the same for practical usage.Here, a very important point to note is that in extremely flat areas the difference between Δh and ΔH will be practically ZERO. Thus, an engineer will be able to use ellipsoidal heights with confidence.

Non-engineering applications revisited

In the paper entitled "When ellipsoidal heights will do the job, why not use them!" *(Coordinates, Vol. 1, No. 3, 2005)*, the use of ellipsoidal heights (h) in non-engineering applications was discussed and explained with full supporting "How to" use them methods and algorithms. No negative critique in writing has been received except on ellipsoid height contours. This critique was that such contours would not work in "general planning" for engineering projects. A double "check" is provided in the following Section.

Engineering applications one by one

Let us now check a number of engineering applications, which we could identify:

1. Ellipsoidal contours on maps – The minimum contour interval (CI) is generally 2 m (or more). In such a case, the accuracy of height information is taken as half the "CI" or ± 1 m (or more). Thus, as there is practically no difference between "Δh" and "ΔH", all road construction work and general planning for canals, pipe lines, etc., can be done with confidence.
2. GPS surveyed "Δh" with accuracy of 1 in 1 million or better – Using for section by section of up to 500-600 meters in length, the ellipsoidal "Δh" will work in canal and pipeline projects even in extremely flat terrains. However, a few small sections of spirit leveling can be done as "check ups". These "spot" checks will help during transitioning from the OLD approach and to develop confidence in the NEW usage.

Conclusions

To use ellipsoidal heights, first we all need to change our pre-determined attitude. Then, accurately surveyed "h and Δh" will do all jobs, including engineering. However, in extremely flat terrain areas, where accurate "slope" is critically vital, a few sections of differential spirit leveling can be carried out as check ups, especially during transition. It will build up confidence. This usage of GPS surveyed accurate ellipsoidal heights will be significantly cost effective and time saving for any project.

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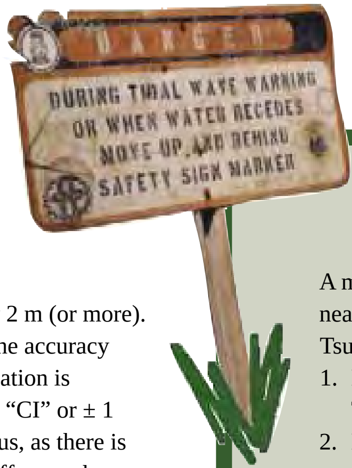


Tsunami Warning System

A major tsunami is caused by an earthquake, which occurs along or near a coast or in ocean area. Thus, a new approach for detecting a Tsunami and issuing the Warning System (TWS) is proposed as under:

1. Establishing an Earthquake Detecting and Tsunami Warning (ED&TW) Center.
2. Detection of exact location of the epicenter and magnitude of the earthquake.
3. Automatic computation using a hydro dynamical algorithm of the amplitude and velocity of the tsunami originating thereof.

This warning from the ED&TW Center would be the quickest possible for coordinated preparedness and management of response from tsunami disaster.

Muneendra Kumar, Ph.D.

Innovative: A 2006 mapping challenge

Kumar Mapping (KMap) System

I recently checked the following two "real" products and my findings are:

1. In Germany, the scale of its basic map series is 1: 5,000 and these maps are then used to produce 1: 25 k and/or 1: 50 k. At this scale for a "normal" size map, the ellipsoidal area covered will be around 2' x 2'. This small size trapezoid will have a "bulge" of about 20 cm and thus, this ellipsoidal area will be 99.9999999.. % or 1 part in 30 million FLAT. The distortion will be zero. This flatness is PERFECT to make distortion-free a KMap and/or KChart. *Challenge # 1: Why would any cartographer would need Mercator or Lambert or Hotine or Polyconic or any other projection to make this 2' x 2' size ellipsoidal trapezoid more flat? Instead, they distort more.*

2. Here, I checked the REAL height data sets for the ellipsoidal heights (h) and the orthometric heights (H) for 11 States, viz., Washington, California, Nevada, New Mexico, Arizona, Texas, Georgia, Tennessee, Virginia, New York, and Kansas. The differences between "Δh" and "ΔH" for the 2' x 2' area covered by a 1: 5 k scale map were less than 2-3 cm and thus, for Contour Interval (CI) even as small as 1 meter, the ellipsoidal height contours will work perfectly. *Challenge # 2: Is there any expert mapmaker who can prove this procedure wrong?*

On 10th April 2005, I had a presentation on "KMap System" in RK Puram, New Delhi, where the eminent SOI and NHO experts, INCA's distinguished members, and ex-SOI galaxy of retired officers were present. My new research of this conceptual approach is more than "an interesting idea". I challenge all Indian cartographers to accept the technique as the 21st century revolution for making maps/charts thousands of time better than the present distorted ones. Let anyone come forward to prove that "It will not work".

The future "quality" of India's DSMs and OSMs is at stake!

Muneendra Kumar, Ph.D.

Recovery status a year after the tsunami: Too late, too slow

The tsunami rehabilitation programme over the last year has been infested with mistakes

ANSHU SHARMA

Mourners and sympathisers across the world remembered the tsunami dead on 26 December 2005, the anniversary of the killer South Asian Tsunami that had claimed close to 300,000 lives a year ago. There were tears, flowers and photographs of the departed – children, women, men, fishermen, farmers, tourists - all kinds of ordinary people.

For all of us it also had to be a day of introspection. Almost everyone had played some role in the immediate aftermath of the tsunami to help the survivors. We had donated money and clothes, we had written about the tsunami, or talked about it, we had advocated and urged others to do something, we had keenly followed the news and felt sad for the affected people. Now is the time to reflect upon what the status of the survivors is a year after the tsunami, and why.

Problems of plenty

The tsunami had set more than one record. Not only was it unprecedented in terms of its impact, but also, for the first time in world history, such huge sums of aid flowed for survivors of a disaster. The amount of private money generated through donations was more than the money made available by governments and inter-government bodies, another first. A large chunk of this money still lies unspent with governments and aid agencies. And yet there is hardly a village where one can today visit and be able to say that the survivors have been properly rehabilitated. Why?

Compounded loss

Besides human losses, the loss to infrastructure, economy and livelihoods was tremendous. These losses were compounded by the fact that establishing these assets in remote and tough locations such as islands or remote coastal areas is far more expensive and time consuming than doing it in normal situations. In the Andaman and Nicobar Islands, maximum impact felt was of the damage to the jetties, affecting the sea based transport of people and goods, the only means of transport in most of the island communities. Damaged powerlines, community buildings, hospitals, schools, petrol pumps, roads and water supply systems were badly affected. Fertile lands earllier used for agriculture turned saline or were completely lost to the sea, boats and nets of fishermen were damaged or lost, and of courses, houses were swept off or broken beyond repair.

As a result, the tsunami left a colossal economic impact. Though, as reported in the media, the impact was not enough to make a dent on the national GDP, it was devastating for the small local economies of the coastal and island communities. The loss of livelihoods, and the basic assets that enable livelihoods, was the biggest blow. Many of the local residents migrated in the aftermath of the tsunami, unable to find the means of re-establishing their means of earning their bread.

Too little, too late

The most critical processes of recovery thus included the rebuilding of livelihoods, shelter and infrastructure, but these have proved elusive for the one year that has passed since the tsunami. There is still no decision on the kind of houses that will be built for the survivors in the Andaman and Nicobar Islands, who still continue to live in temporary tin shelters. The resources seem to be available, but the will and abilities of the various sectors involved in the response seem to have been lacking.

Governance: the underlying factor

The key factor leading to avoidable poor performance is that of governance. Governance is not just about governments. It has an equally important stake of the civil society. At a broader level, governance is also a determinant of a community's resilience in terms of the building and management of its assets. These assets include physical, social and financial assets that protect a community from disasters. Physical assets include safe settlements, houses, infrastructure and community buildings; social assets include family and community structures and associations; and financial assets include savings, insurance and credit opportunities. The very fact that such extensive damage took place in areas that are known disaster-prone zones is a reflection of governance failure.

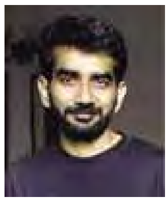
Another aspect of governance is its capacity to respond quickly to emergencies, and its mechanisms to facilitate aid to the needy. It needs to have established structures that carry out developmental work in peace times, and can be upgraded to conduct recovery work when needed. This also raises the need to have systems to locally take quick decisions on extraordinary issues. The immediate relief efforts, jointly conducted by the government agencies and the voluntary organizations were commendable, and it can be said with pride that there was no shortage of basic survival items such as food. However, the recovery process that followed was riddled with problems. Our planning, design and engineering sectors, who can boast of the best of the skyscrapers and bridges built in record time, were unable to provide even basic dignified shelter to the survivors even a year after the tsunami. The Andamans are still without jetties, Greater Nicobar still without roads, thousands of survivors on the islands and the mainland still without permanent homes, schools still without buildings, and men still without jobs. The irony of relief is that there are also those places where men are without jobs because of relief! In fisher communities where a group of five men goes out fishing together, with one owner and four labourers, now there is a problem in forming such groups since aid agencies have given every man a boat. With more boat owners than workers, there is an economic as well as social chaos that aid has created.

Learning the lesson

It is said that when you make a mistake, don't lose the lesson. The tsunami rehabilitation programme over the last year has been infested with mistakes. Now is the time to look back, learn the lessons, and make a pledge to act more wisely in the new year. Information has to be generated and synthesised, plans have to be made and publicised, and implementation has to be carried out on the fast track.

For all of this to take effect, deliberate efforts will need to be made both at policy and practice levels. Governments and donor agencies have the primary responsibility for creating the right policy and strategy environment. Governments need to establish regulatory as well as incentive based mechanisms to ensure not just equity of resource allocation, but also delivery and impact. Institutional donors in the present context influence field practice in a significant way. Their requirements determine the manner in which thousands of field implementation partners act on the ground. Insensitive pressures to dispense funds can create havoc in communities where aid is dumped and can have long term detrimental effects including physical, social and economic ones. The worst of such impacts is the demolition of a community's internal coping capacities by creating a dependence on external aid. Responsible donor agencies consciously follow the `do no harm' approach, but this approach needs to become the norm of practice in the humanitarian aid sector.

Field based NGOs and communities get listed last, but have perhaps the most important roles. Many of the issues discussed in this article can be addressed in a sustainable manner only through a community based approach. Networking between governments, NGOs, academia, media and the community is a cruicial link for basing actions on informed decisions, and for improving practice based on lessons learnt.



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Rationalizing the village planning process

In order to initiate the village planning process, a standardized village planning methodology has to be developed

Akshima Dogra

About seventy three percent of the population of India is rural and inhabits around six lakh villages. Despite such a large percentage of population staying in villages, not much has been done to plan for these settlements; the villages in the country are growing in an unplanned manner. There is no integrated approach to future village development, especially on a spatial level. In addition to lack of political will, infrastructure, trained professionals, organizational set up, financial assistance etc., two important components are missing. Firstly, there is a lack of standardized village planning methodology. Secondly, there is absence of a standardized and integrated information system especially for spatial planning. Until these two basic components are addressed, village planning cannot become a reality in the country.

To initiate the village planning process, a standardized planning methodology has to be developed. It should address the issues of micro planning, integrated spatial development and horizontal as well as vertical integration of plans. Modern techniques like GIS, GPS, Remote Sensing etc. should also be used.

There are a number of village planning methodologies/processes that exist in the country but with differing aims their approach is piece meal. These processes reveal few common weaknesses, e.g.,

- Lack of an integrated spatial, socio-economic approach for village development.
- Lack of public participation in the planning process.
- No consideration given to the horizontal and vertical links of village with its surrounding villages and higher spatial units (district and block) respectively.
- Very long plan period.

The standardized village planning methodology has to address all these problems. Flow Chart-1 represents such an evolved village planning methodology that addresses all these issues. It includes new stages in the village planning process that will rationalize the process.

The village planning methodology, thus evolved, involves many stages that are missing in the traditional village planning process. These stages need to be supported by the Planning Information System. The information system will help in making the planning process more transparent, rational and efficient in terms of both resources and money. The Flow Chart-1 also gives a broad framework of Geo Spatial Information System Model that will support this village planning methodology.

The Planning Information System will intervene at almost all the stages of the evolved village planning methodology. This leads to heavy dependence of the application of the methodology, on the information system. This dependence of the entire planning system on such an information system helps to make our planning process more efficient and reliable. It encourages planners to work in an environment which is more rational, logical, reliable, transparent, easy to understand and above all efficient.

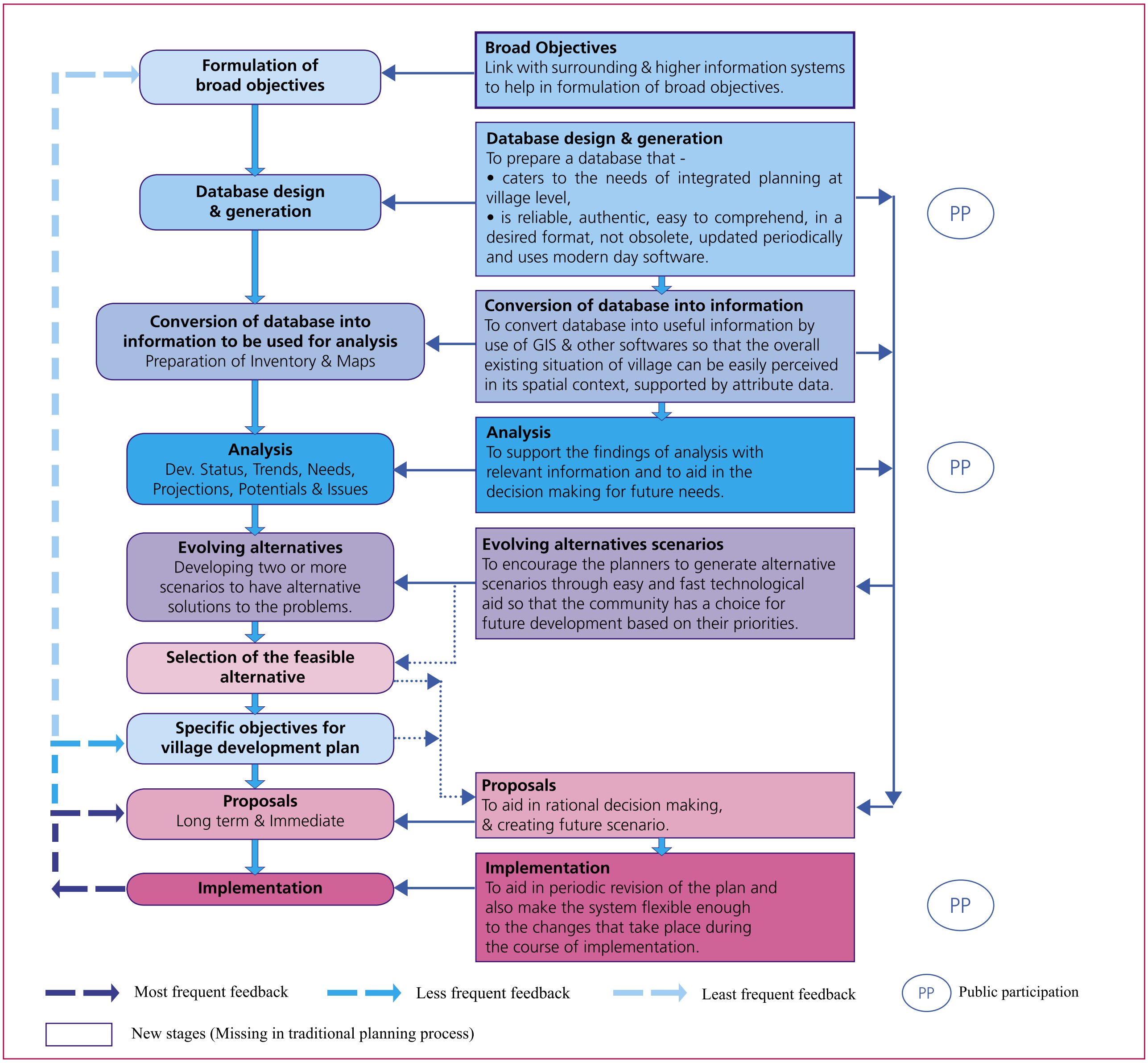
The most important component of the planning information system is the database generation and storage and then its conversion into useful information for analysis of existing scenario of the village. This stage often gets little concentration in our traditional planning process but with the development of such information system based planning process, this problem of underestimation of database can be solved. The main problem with the existing databases is their large and complex nature. This complexity has been reduced in this model by dividing the entire database into two categories, i.e. Essential and Desirable data sets. The information system helps in the-

- Classification of data into 'essential' and 'desirable'. Essential data is very critical for decision making, is easily available and quite accurate. Planning can start with this set of data and the desirable dataset can follow.
- Standardization of data requirements for village planning.
- Standardization of source, format, spatial level and time period (cycle) for collection of data.

These features of the Information System are addressed in Flow Chart-2

Another lacuna in our existing method of plan formulation is the negligence about the difference between 'data' and 'information'. Information to be derived from the database, hence, needs to be standardized in the Information System framework. The spatial level at which the information is required and the format in which it is required also need to be pre determined to avoid any problems or mismatches at later stages of plan preparation. The Flow Chart-3 explains these aspects of the Information System.

Flow Chart-1 Broad framework of the evolved village planning methodology supported by the Geo-spatial information system, Source- Dogra, Akshima; 2005.



This standardization process is very important for applying this village planning model in all parts of the country. Other important contributions of the Geo-Spatial Information System based village planning methodology are –

- Integrated planning of villages as all sectors, spatial and non-spatial, are considered while preparing the village development plan.
- Rational decision making through standard database & information.
- Public participation in the entire planning process as it is easy to involve people due to efficient data management techniques.
- Linking village development with its context i.e. surrounding villages and higher spatial units i.e. district and block.
- Development of alternative future scenarios for village development as it is easy to develop alternatives within a short period due to availability of required database in the system itself.
- Monitoring of plan proposals and periodic revision of village development plan due to frequent feedback from implementation of plan proposals inbuilt in the system.

Development of such an information system based village planning methodology would also help achieve the objectives of 73rd Constitutional Amendment Act i.e. decentralization and would help take the spatial planning to the micro level of the settlement hierarchy.

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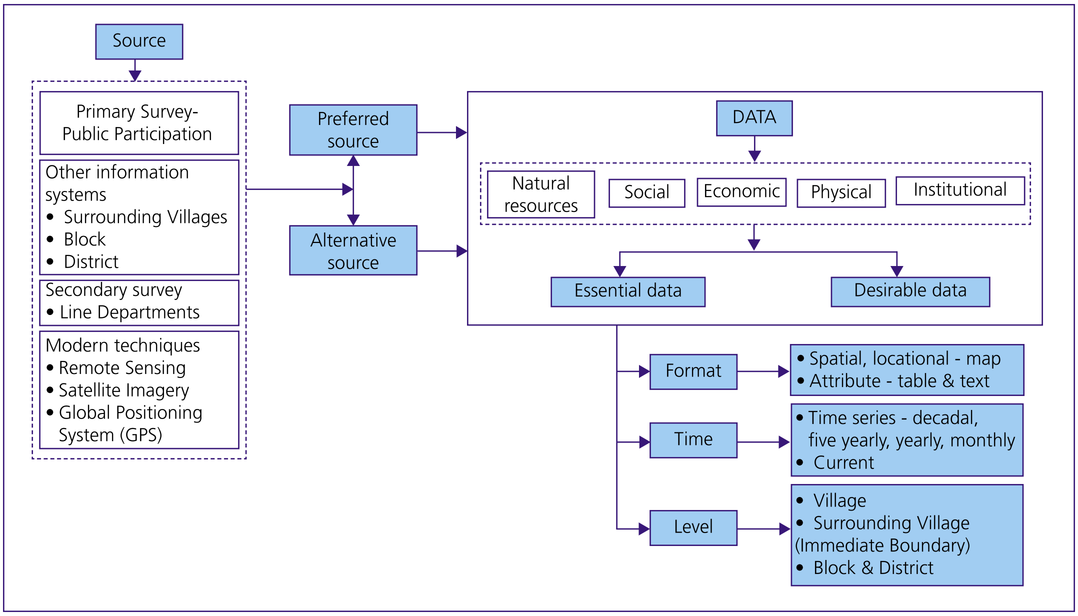

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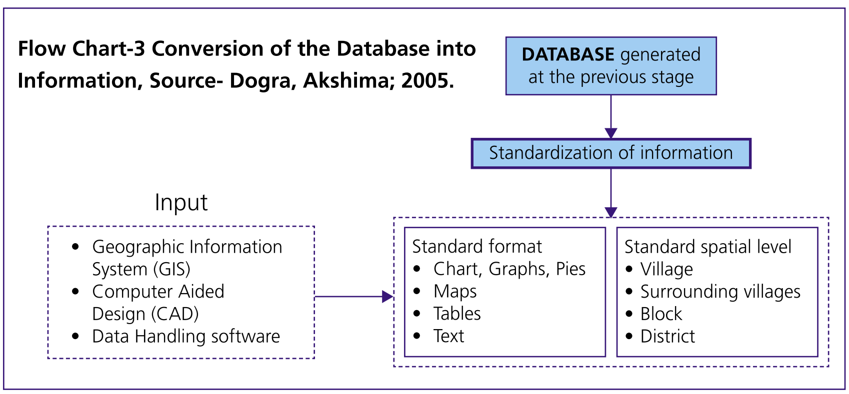
Flow Chart-3 Conversion of the Database into Information, Source- Dogra, Akshima; 2005.



25th INCA Congress

A report

Chief Guest Balram Jakhar releases a magnum opus on Native Indian Cartography

Dr HS Gour University, Sagar (MP) organised the 25th International Cartographic Congress of Indian National Cartographic Association (Nov. 28 – Dec. 1, 2005). Focused at "Bridging the Digital Divide and Taking Cartography to Grassroots Level" the Congress was attended by more than 300 delegates.

Inaugurating the Congress, HE Dr Balram Jakhar, the Governor of Madhya Pradesh expressed his hope that the deliberations of the Cartographic Congress will contribute to the fuller utilization of Spatial Information Technology that India has achieved. He also gave away Eicher Trophies to the winners of the National Map Quiz.

While the Presidential Address by Prof J L Jain pinpointed at a fuller cartographic education in academia as the key to progress of GIS in India, keynote address of the INCA CO-President and Surveyor General of India, Maj. Gen. Gopal Rao (read out by Add. Surveyor General, Brig. M V Bhat) presented a succinct survey of the Cartographic scenario in the country in the wake of IT revolution and its concomitants like spatial data infra-structure, new geo-spatial data policy and man-power development. Besides releasing the Souvenir-cum-Abstracts volume, the Chief Guest also released a magnum opus on Native Indian Cartography done by Prof B Arunachalam and published by INCA.

Delivering the Raja Todarmal Lecture, the veteran Prof Arunachalam, focused on Indian moorings of new mapping endeavours of the Europeans in India in the 18th Century. Dr P Nag, Director, NATMO delivered the newly instituted Padma Bhusahn Prof S P Chatterjee Memorial Lecture, wherein he comprehensively brought to focus the contribution and personality traits of this doyen of Geography and Thematic Cartography in India.

In all more than hundred papers were presented in a dozen technical sessions, besides several poster presentations. For the first time sessions were held in Hindi language also.

Vendors' session also featured several impressive presentations. Technical exhibition featured Rolta India, Topcon, AutoDesk, etc. from private Industry, and Survey of India, NATMO, NRSA, MP Council of Sc. & Tech., etc. among Govt. organizations.

The Panel discussion dwelt on problems of Social Science disciplines in utilizing Geo-informatical tools & techniques, and on complementary vs. the competitive nature of relationship between GIS and Cartography. Valedictory session of the Congress had the veteran Geophysist, Dr J G Negi, Dy D G of MP Council of Sc. & Tech., Bhopal as the Chief Guest.

Institution of Surveyors AGM

The 49th Annual General Meeting of Institution of Surveyors was held in New Delhi in the last week of November. In his inaugural address, Lt Gen Ranjit Singh, SM, Engineer-in-Chief and Senior Col Comdt, the Corps of Engineers said Institution of Surveyors during its last fifty five years of existence, has brought various survey disciplines under one umbrella. In 1949, the country boasted of only 400 surveyors when the idea for this institute was mooted by the then Surveyor General of India. The institute started with only two sub divisions ie Land survey and Bldg and Quantity Survey. With the advent of time there has been manifold increase in the number of survey disciplines under the institute. He said that Land Survey forms the very basis of land records and their holdings. Indian Surveyors over the ages have done yeoman service in drawing up these records initially on cloth and paper and now digitally. Although we have a long way to go before we reach the goal of all such records being digitized but we have at least embarked on this road. While appreciating the need of speedy development of the surveying profession, he emphasized that the training facilioties for the growth of the profession need to be accelerated and strengthened since the number of qualified surveyors in various disciplines are not available in accordance with the demand. The meeting was also addressed by Mr K K Chakrabarti, President, Institution of Surveyors, Brig P K Bhatnagar, AVSM (retd), Outgoing President, and by Brig P N Kaul.

GNSS 2005

The International Symposium on GPS/GNSS was held in Hong Kong 2005 during 8-10 December 2005. The symposium was organized by the Hong Kong Polytechnic University and sponsored by Trimble, Leica, Topcon, Spirent and Star Vision, GPS World, GIM International and Coordinates. The symposium was atteended by more than 200 delegates all across the world and round 150 papers were presented in the symposium. There were very interesting presentation on development and trend of GNSS by the leading experts. Some of the key speakers were Vidal Ashkenazi, Nottingham Sceintific Ltd, UK; Per Enge, Stanford University, USA; Ronald Hatch, NavCom technology, USA; M E Cannon, Canada. Dr Vidal gave a brief overview of the current and developing GNSS scene. Prof Enge deliberated upon the augmentations of GPS and Galileo. Prof Jingnan Liu made a presentation on "Frame and construction of integrated satelite navigation system in China."

There was session on CGSIC where presentations were made by John Wilde, CGSIC Deputy Chair for International Affairs; Matt Blizard, NAVCEN USCG; Jim Miller, US DoT; Rebecca Casswell, USCG; Dan Hanlon, FAA; Don Sinnott, Chairman Australian GNSS Coordination Committee; Hiroshi Nishiguchi, Japan GPS Council; Sang Joeng Lee, Chungnam National University. In the ensuing panel discussion experts discussed a range of issues from conflict, complementarity and compatibilities of GPS and Galileo in an interactive discussion. The panel was chaired by Prof Yongqi Chen. There were many technical sessions on various topics including GNSS/INS integration, atmospheric effects, timing, RTK positioning, Network infrastructure, etc.

Earth Commission:
A new initiative in India

The Earth Commission — the first of its kind in any country, will pursue an integrated approach of research to tweak meteorological data for accuracy and reliability. Meteorologists, geo-physicists, oceanographers, atmospheric scientists and space scientists will pool their expertise.

CNR Rao, Chairman of the Prime Minister's Science Advisory Council, told HT, "We have taken a holistic view of earth science. Kapil Sibal (Science and Technology Minister) has endorsed our opinion. The Prime Minister has received our report. It (the new commission) will be placed before the cabinet for approval." The Earth Commission will be structured along the lines of the space set-up, with three rungs, namely, the Earth Commission, the Department of Earth System Science (DESS) and the Earth System Science Organisation (ESSO). The commission, its department and research organisation will have a single head, just as with the space agency.

The panel's agenda

- To provide the best service in forecasting natural disasters and their impact on the sub-continent.
- Work with other agencies (PMO, Ministry of Home, DST, ISRO etc) to provide alerts on drastic changes in the climate and looming disasters in order to manage them.
- Offer extensive data on water and land to manage these resources as well as to support agriculture and aquaculture. The data on oceans will support fisheries (location of new fish catch) and in spotting fuel deposits.
- Put together processed data on earth and climatic parameters that are critical for scientific and industrial activity.
- Support research activity in Earth System Science (ESS) and enhance the human resource base in this field through a special funding mechanism.

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MARK YOUR CALENDAR

January 2006

Informatics for Geoinformatics
23-25 January 2006 Ostrava, Czech Republic
www-gis@vsb.cz.

Regional GBIF training workshop
25-27 January 2006. Lucknow, India
www.gbif.org.

February 2006

National Conference of Earthquake Analysis and Design of Structures EQADS-06
2-3 February, Coimbatore, Tamil Nadu
eqads-06@mail.psgtech.ac.in, eqads06@yahoo.co.in
http://www.psgtech.edu

Commercial Remote Sensing Industry Conference
9-10 February, Washington, DC
kbechor@srinstitute.com
http://www.srinstitute.com

International LIDAR Mapping Forum 2006
13-14 February, Denver, U.S.A
organizer@lidarmap.org.
http://lidarmap.org/conference.html

International GIS Conference & Exhibition
13-15 February, Kuwait
http://www.gulfgis.com/

March 2006

Second Annual Australian Chapter Geo Forum
1-3 March, Queensland, Australia
http://www.intergraph.com.au/iguc2006

GPS-Wireless 2006
2 - 3 March, San Francisco, CA
http://www.gps-wireless.com

The 6th Asia Mobile Location Services (MLS) 2006
20-31 Mar, Bangkok
enquiry@ibcasia.com.sg

April 2006

IEEE/ION PLANS 2006
25- 27 April, San Diego, CA United States
http://www.PLANS2006.org

Geo-Siberia 2006
26-28 April in Novosibirsk, Russia
http://www.sibfair.ru/en/ex-hibition.php?id=533

May 2006

The North American Defense Geospatial Intelligence Conference
8-10 May, USA
dgi@wbresearch.com

4th Taipei International Conference on Digital Earth
25- 26 May, Taiwan, Taipei
derc@mail.pccu.edu.tw
http://deconf.pccu.edu.tw/

June 2006

International Conference in GIS and Health
27-29 June, Hong Kong
chankw1@hkuoc.hk
http;//geog.hku.hk/HealthGIS2006

July 2006

3rd Annual Meeting (AOGS 2006)
10-14 July, Singapore
http://asiaoceania-conference.org/

COAST - GIS 06
13-17 July Wollongong and Sydney, Australia
http://www.uow.edu.au/science/eesc/conferences/coastgis06

IGNSS 2006 Symposium on GPS/GNSS
17-21 July ,Gold Coast, Australia
http://www.ignss.org/conf2006/index.php

August 2006

International Workshop on 3D Geoinformation
7-8 August, Kuala Lumpur Malaysia
alias@fksg.utm.my
http://www.fksg.utm.my/3dgeoinfo2006

Digital Earth 2006
27-30 Aug
http://www.digitalearth06.org.nz/. mail-to:james@eventdynamics.co.nz

September 2006

17th UNRCC for Asia and the Pacific/ 12th Meeting of the PCGIAP
18-22 September, Bangkok
http://www.gsi.go.jp/PCGIAP/

October 2006

XXIII International FIG Congress Back
15-20, Germany, Munich
http://www.fig2006.de/index2.html
Office@fig2006.de

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

Geoinformatics 2006
20-21 October, Wuhan, China
lilyshi@lmars.whu.edu.cn

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