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# Coordinates

MONTHLY Volume II, Issue 6, June 2006

POSITIONING, NAVIGATION AND BEYOND

# MyRTKnet
## Get set and go!

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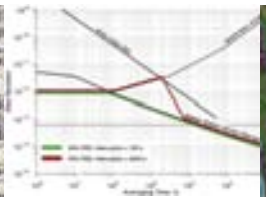



## Columns



cGIT 28A Pocket D, SFS Mayur Vihar Phase III, Delhi 110 096, India. Telefax +91 11 22632607, 98107 24567, 98102 33422 Email [information] talktous@mycoordinates.org [editorial] bal@mycoordinates.org [advertising] sam@mycoordinates.org [subscriptions] iwant@mycoordinates.org Web www.mycoordinates.org

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

## The SHARP edge of Mt Everest

David Sharp was left to die.

Many saw him.

They didn't do anything.

Perhaps they could not.

Perhaps it was 'impossible' to do anything there.

They continued climbing…

Conquered Mt Everest.

Sir Edmund Hillary is outraged.

He knows what they lost.

But it happens.

Everyday and everywhere.

People are allowed to die.

Who cares?

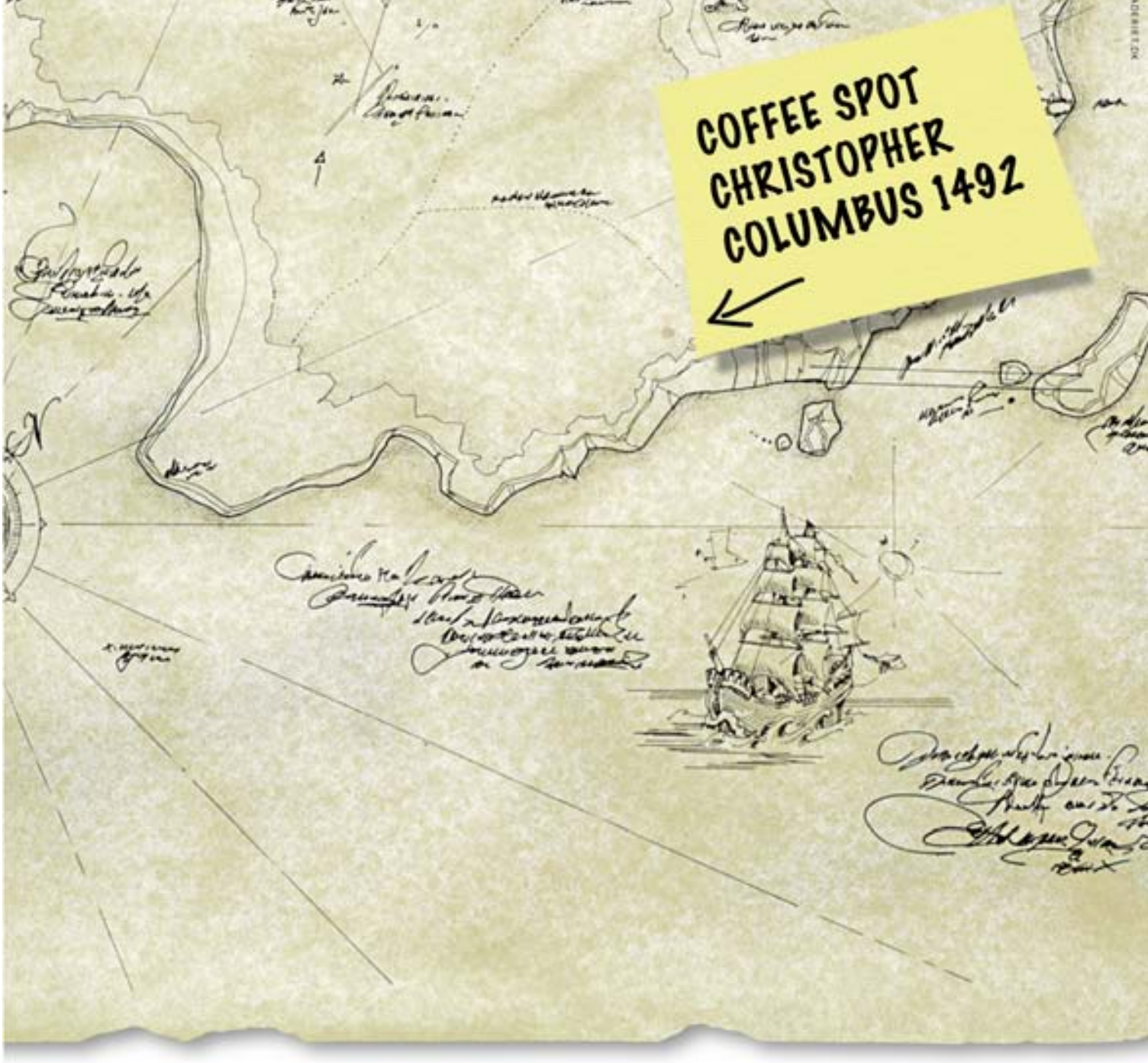
The 'ultimate' is just to be on the top.

Let us climb up and up.

Leaving those who can't.

Can you?

**Bal Krishna, Editor**
**bal@mycoordinates.org**

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# MyRTKnet: Get set and go!

MyRTK network is an effort to use real-time survey technology for the enhancement of many services and dissemination of various geodetic products

**Dato' Hamid Ali, Ahmad Fauzi Nordin, Dr Samad Hj Abu, Chang Leng Hua**

The Department of Survey and Mapping Malaysia (JUPEM) is the competent authority in providing both horizontal and vertical survey control to the surveying community in Malaysia. This is carried out through the setting up of a surveying infrastructure throughout the country for the eventual purpose of national development, security and defence. In line with the government's endeavour to improve its delivery mechanism, there have been many initiatives made by JUPEM. One of them is the effort made to use real-time survey technology for the enhancement of its many services and dissemination of various geodetic products rendered by the department.

From 1997 to 2000, JUPEM has set up a permanent GPS network known as Malaysia Active GPS System (MASS) which consists of eighteen (18) stations located at a spacing of 200 - 300 km from each other. Each station of the network is equipped with a high precision dual frequency GPS receiver that is operational 24 hours daily. The acquired GPS data is transferred on a daily basis to the Central Processing Centre at JUPEM's Headquarters in Kuala Lumpur via modem/internet. This permanent GPS stations network is an integrated geodynamic network and the zero order network for the realization of the National Coordinate Reference Frame, which is known as the Geocentric Datum of Malaysia 2000 (GDM2000).

Presently, MASS provides an excellent frame of reference for geodetic positioning in Malaysia, and several kinematic applications have been carried out by post-processing thedata. However, the possibility of having real-time access to the data observed by the GPS network would dramatically and clearly increase its synergy with land surveying activities. For instance, it would allow the use of GPS for centimeter positioning over the entire territory of Malaysia through the broadcasting of RTK corrections.

### Existing Scenario

Real-Time Kinematic (RTK) is now widely used for surveying and other precise positioning applications. The classical RTK technique requires that GPS data be transmitted from a single base receiver to one or more roving units.

RTK can provide centimeter position accuracy, but the accuracy and reliability of the standard RTK solution decreases with increasing distance from the Base Station. This limitation on the distance between the roving GPS receiver and the RTK Base Station is due to the systematic effects of ephemeris, tropospheric and ionospheric errors. These systematic errors result in reduced accuracy and increasing initialization time as the distance between base and rover increases.

Besides the aforementioned constraint, the limitation is also due to the range of available radio telemetry solutions. In practice, this means that a temporary RTK Base Station must be established close to the work area, often at a location that does not provide any physical security or continuous power supply. Each time such a temporary reference station is established, there is a likelihood of introducing an error in the reference station coordinates that will be transferred into the position calculated by the rover RTK receiver. Such an error can easily go undetectedwhen using a single base station.

### Objectives

In order to take full advantage of the real-time capabilities of the RTK network, MyRTKnet has been designed with the following objectives:

i. To establish a network of permanently running GPS base stations, at a spacing of 30 to 150 km, feeding GPS data to a processing centre via frame-relay IPVPN communication network.
ii. To establish a central facility that will model the spatial errors which limit GPS accuracy through a network solution and generate corrections for roving receivers positioned anywhere inside the network with an accuracy better than a few centimeters (dense network) to a few decimeters (sparse network) in real time.
iii. To establish a web site that will make available near real time (1 - 3 hours) reference station data to the users for post-processing differential GPS throughout the coverage area.

## Network design

### Objectives

The primary goals in designing the system were for efficient and easy operations, facilitate user understanding of the network and for expandability. Some empirical numerical limits have been suggested for IP addressing and efficient operation of the system. The networking protocol used is the Internet Protocol (IP).

Though contained in a single private network, the system was split into 2 subnets which is not representative of classical IP subnet class. As such this network is considered as 'classless'. Each subnet consists of all reference

stations and the Control Center (also referred to as central control or CC).

### Malaysia Real Time Kinematic GPS Network (MyRTKnet)

The RTK Network Solution concept is based on having a network of twenty-seven (27) GPS reference stations continuously connected via IP VPN to a Control Centre (Figure 1). The computer processor at the Control Centre continuously gathers the information from all GPS receivers, and creates a living database of Regional Area Corrections.

### Physical Communications

The physical communications infrastructure is provided by the IPVPN over COINS frame relay system. This system works by connecting any respective site into the Telekoms Malaysia frame relay network. The service is available throughout Malaysia except for some isolated locations. The advantage of using IPVPN verses point to point leased lines is that IPVPN will require only a single high speed connection and modem at the Central Control rather than a connection comprising of a modem and separate leased line for each station. A schematic representation of the system communications is shown in Figure 2.

## Reference stations

### Physical Enclosure

The physical enclosure for the equipment at each site is a small

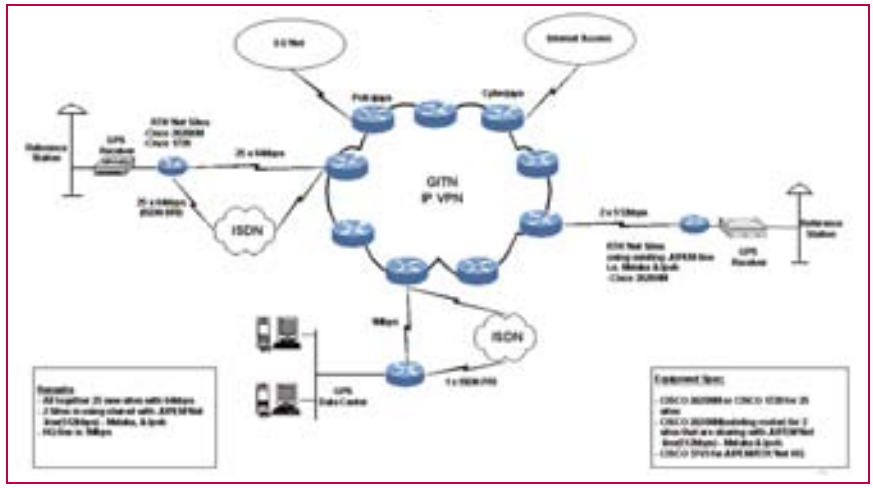


**Figure 2: IPVPN Networking**

structure or allocated room of approximately 3m x 4m. This room is being cooled by 2 air conditioners that alternate during the day such that the total time that any one unit is on over the entire day is 12 hours.

### System Schematic

The system schematic for the reference stations are shown in Figure 3.

The Reference Station consists of the following:

- Cisco 1721 router
- Dlink 5 port 100/10M switch
- Trimble 5700 CORS with Zephyr antenna
- Moxa 5410 terminal server
- Advantech Adam 6017 A/D module
- Micromate UPS for minimum 2 days backup power
- Satelit lightning protection

The system is designed for autonomous operation and is able to run for 48 hours without power.

**Figure 1: MyRTKnet**

## Central Control KL

### Hardware

The hardware for the CC KL configuration is shown in Figure 4.

The Control Centre consists of the following:

- GPSNet1 server for hot swap redundancy
- GPSNet2 server for hot swap redundancy
- Maintenance server for system monitoring and data archiving
- 3745 router for access to the Internet and GITN cloud
- HP Printer
- UPS to hold the system for 3 days backup
- Monitor for GPSNET Servers
- Monitor for GPStream Server
- KVM Keyboard for GPSNET Servers
- GPStream server for web server and data distribution
- Monitor for Maintenance Server
- 3COM 10/100/1000 switch to interconnect all components

### Computer systems

The system comprises 3 HP Proliant servers and a single rack mount router computer, GPStream server.

Each of these computers and their respective function are discussed below.

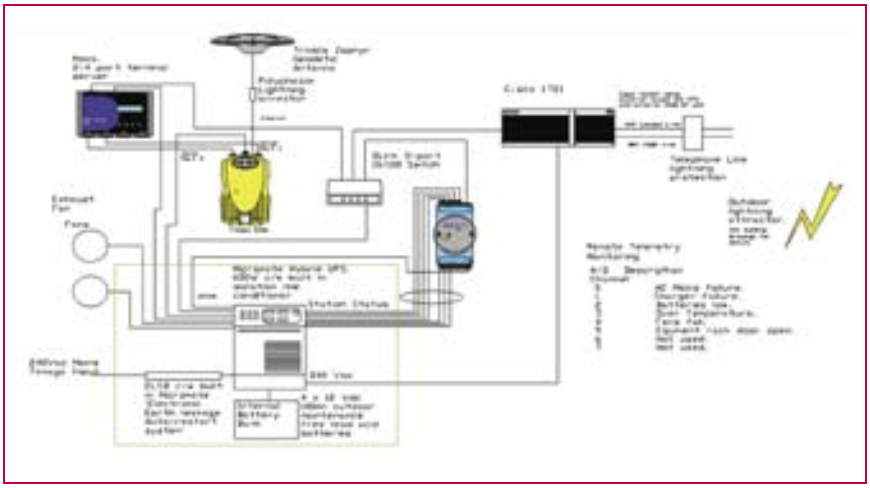

**Figure 3: Reference Station Schematic**

## GPSNet servers

The VRS computers are server grade HP Proliant computers configured in a pure 'hot standby' mode and are designated as VRS primary and VRS secondary, GPSNet1 and GPSNet2 respectively. Each of the servers is on line with the VRS application running. Both servers receive data from all the reference stations, logging these RINEX data and deliver RTKnet corrections when connected. However, it is the function of the GPStream server to distribute the reference station receiver data to the GPSNet servers and controls which server get user requests for RTKnet or DGPSnet corrections.

Since both servers are online, should GPSNet1 server fail to operate, any online field user receiving RTKnet or DGPSnet corrections will lose their connection and the line will hang up. As soon as the field user calls back in, the GPStream server will detect the failure of the GPSNet1 server and will pass the request from the user to GPSNet2 server. Since both servers would be continuously logging data, none of the logged RINEX data would be affected.

## VRS router Computer – GPStream Server

The GPStream Server has two functions:

- To distribute the raw RT17 data in real-time from the reference stations the GPSNet1 and GPSNet2 servers.
- To route the requests from the users to the online VRS server.

User requests for RTKnet or DGPSnet corrections are sent to the GPStream Server. The GPStream Server is in continual communication with both GPSNet servers and as aforementioned, can detect the failure of one in seconds. If GPSNet1 Server does not respond to the GPStream Server's requests, it will forward the corrections' request to the next server in its list, in this case the GPSNet2 Server. Since the GPSNet2 Server is already online and the ionospheric model computed, corrections will be delivered to the field user almost immediately.

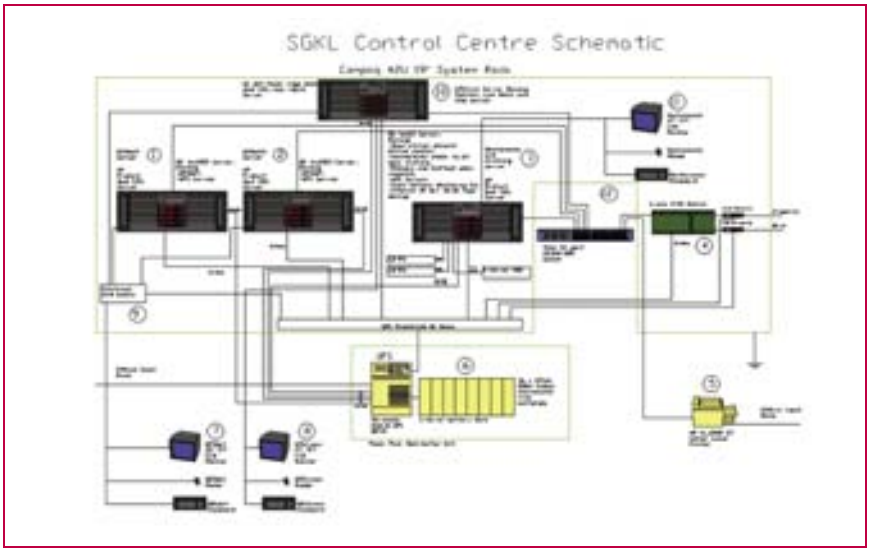


**Figure 4: Hardware for CC KL**

The GPStream server is essential for the operations of the system; so it is built in a dual power supply rack mount chassis and uses RAID hot swap hard disks so as to minimize possibilities of failure.

## Maintenance and Archiving Server

The maintenance and archiving server is used for archiving RINEX and alarm data to CD and for monitoring the physical status of the reference stations. An application running on the archiving machine will check the reference station status every 5 minutes. Also on this machine is an application that make at every second to check which users are logged onto the system. This data is logged so that phone billing records may be cross checked.

All computers are located in a 42U 19" rack with the GPSNet servers and the GPStream server sharing a monitor, keyboard and mouse via a KVM switch and the archiving/maintenance server having its own monitor, keyboard and mouse. All monitors, mice and keyboards are located at work table near the rack. Telnet access to the routers and remote sites are done from here.

# Virtual Reference Station

## Reference Station Connections

The Trimble 5700 has its serial ports 1 and 3 connected to the MOXA's Terminal Server (TS) serial ports 1 and 2. The MOXA's TS serial ports behave like TCP ports. MOXA TS serial port 1 is assigned TCP port 4001 and port 2 TCP port 4002. Both TCP/IP sockets that are connected to the GPS receiver's

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serial ports are configured in 'server' mode which means they are waiting for connections from a socket client.

The GPStream server is configured to connect to the reference stations in socket client mode. This connection will initialize the receiver and start the RT17 data stream. It will then setup socket servers that can be connected to by the GPSNet servers to receive the streamed RT17 data. In this way both GPSNet servers will receive the data rather than only one. This connection will initialize the receiver and start the RT17 data stream.

### Remote User RTK or DGPS Call In

GPSNet is configured in socket server mode for the RTKNet and DGPSNet modules. The remote user will use the registered Telco Mobile Phone Internet Connection through GSM or GPRS to access the Control Centre KL. When a call comes in, the router will authenticate the user before connecting to the system, by using the username and password. If it is in the authorization database, the connection is allowed to proceed, else the line is dropped. When the connection proceeds the router brings the line up and immediately connects to the appropriate socket on the GPStream server. The GPStream server then queries both of the available servers. If they both answer, the request is sent to GPSNet1 server. If only the secondary answers the request is then sent there. The GPStream server will continue to forward requests to and from the GPSNet servers. The field user is now connected and following the reception of a GGA NMEA string by the GPSNet server, GPSNet will begin sending RTK or DGPS corrections from a 'virtual base' whose coordinates are based from the field user submitted GGA string.

### Archiving/Monitoring

User accounting will be done from the archiving and maintenance server. An application will make query every second to check when users connect and disconnect to the server. The time the connection was initiated and the time the connection was terminated will be logged to a file.

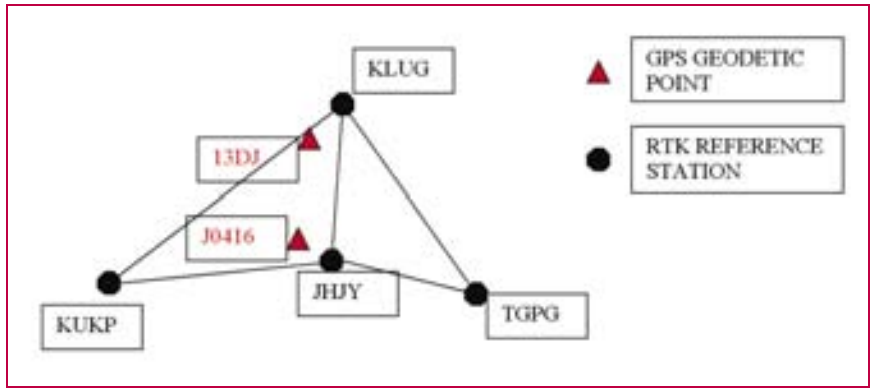


**Figure 5: JOHOR BAHRU Dense Network**

### Hot Swap

The system proposed runs the GPSNet servers in a 'hot standby mode' in which the secondary GPSNet2 server is up, connected to the reference stations and running VRS. The GPSNet2 server is also logging RINEX data along with the primary GPSNet1 server. The only thing that will happen when GPSNet1 sever fail is that the GPStream server will forward RTKnet and DGPSnet corrections' requests to the GPSNet2 server. Thus, switching to the standby system will be done in seconds after the fault is confirmed rather than the 20-30 minutes with the clustering solution.

## MyRTKnet SERVICES

### VRS Correction

a) Within the limits of our MyRTKnet Dense Network, MyRTKnet provides VRS GPS corrections with an accuracy of 1 to 3 cm horizontally and 3 to 6 cm vertically.
b) Distance dependent errors are considerably minimized with utilization of the MyRTknet network, thereby achieving increased accuracy and reliability.
c) RTK Surveying works at its optimum with a base station network to achieve the pinnacle of RTK Technology production potential.

### Static Correction Data

a) Within the larger limits of the Single Base Station Coverage, MyRTKnet Solutions provides data for post-processing of static survey sessions, enabling positioning in the order of 1 cm or even millimeter recovery limit. The data is provided in the standardized RINEX format and is available via our password protected internet website.
b) Information with a data rate of 1-15 seconds is stored indefinitely.
c) Post-processing provides the highest accuracy and is suitable where increased precision is required.

### DGPS Correction

a) This application is a sub-meter Mapping and Navigation Technology.
b) The service provided by MyRTKnet Solutions includes data for post-processed positioning and Real Time Correction. Any receiver that is capable of Real Time Corrections and cell phone data service can be used to receive MyRTKnet Solutions' Real Time RTCM corrections.
c) Distance dependant errors are eliminated for users' observations due to MyRTKnet Solutions' array of base station locations.
   - Mapping and Navigation
   - Other Sub-Meter Uses

### Hardware Requirement

MyRTKnet Solutions correction can be applied to any mobile receiver capable of connecting to a data cell phone. Cell phone reception, therefore, is a requirement of the VRS correction service. Presently, there are

**Table 1: Observation Criteria**

| | |
|---|---|
| Observation Session | 5 sessions in 10 measurements each |
| Recording interval | 1 sec data |
| Number of satellites | ⩾ 5 |
| GDOP | ⩽ 6 |
| Sky Clearance | ⩾ 90 % |
| Cut Off Angle | 15 % |

mobile receivers which has both the capabilities of wireless connection to the cell phone and data collector. Any single or dual frequency GPS receiver can be used to collect data and for static correction data application, post-processing software package is needed to reduce the data to final position that uses standard RINEX files.

### Possible Field Applications

MyRTKnet services can be used for various surveying applications ranging from setting up of control to the detailing of project sites; its usage will benefit surveyors and many other GPS users who rely on these utilities to locate their positions. The following are some of the possible field applications of MyRTKnet services:

- Engineering Survey
- Topographic Survey
- Boundary Survey
- Construction Staking
- Utility Extension Survey
- Flood Survey Study and Analysis
- Photogrammetric Control Surveys
- GIS Applications
- Control surveys for monumentation
- Wetland Location Surveys
- Soil Location Survey
- Flagging Clearing Limits
- Tree Surveys
- Mapping and Navigation

## MyRTKnet testing

### Case study for high accuracy VRS correction test

a. The objective of the High Accuracy VRS Correction Test is to compare GPS observed coordinates with their corresponding published GPS geodetic values. The test was carried out at the existing GPS geodetic network in the Dense Network. An example of the layout of the network test site is shown in Figure 5.

b. The Dense Network consists of 3 sites located at Klang Valley, Penang and Johor Bahru. For this case study, Johor Bahru Dense Network was selected .This site comprises of four (4) GPS reference stations (known stations) namely KUKP, JHJY, TGPG and KLUG. The test was carried out using VRS technique with 5 sessions of observation (consisting of 10 measurements in each session) on 2 GPS receivers.

c. Dual frequency GPS receivers were used in the test with the observation criteria as mentioned in table 1.

d. The final observed coordinates values as mentioned in table 2 were the results of the average of the whole set of observations.

e. The results show that the accuracies in the horizontal and height component were less than 1 cm and 9 cm respectively. It also shows that for areas within 30 km from the network, the accuracies obtained were within the said levels.

**Table 2: High Accuracy VRS Correction Test Results**

| Station Name | Observed Coordinates | Known Coordinates | Difference ( m) |
|---|---|---|---|
| **North Component** | | | |
| 1. J0416 | 1° 27' 42.50174 " | 1° 27' 42.50173 " | 0.001 |
| 2. 13DJ | 1° 49' 39.95325 " | 1° 49' 39.95309 " | 0.004 |
| **East Component** | | | |
| 1. J0416 | 103° 46' 24.09220 " | 103° 46' 24.08998 " | 0.005 |
| 2. 13DJ | 103° 38' 24.93991 " | 103° 38' 24.93867 " | 0.037 |
| **Height Component** | | | |
| 1. J0416 | 11.943 | 11.866 | 0.082 |
| 2. 13DJ | 49.357 | 49.353 | 0.004 |

### Case study for Network base DGPS correction test

a. The objective of the Network Base DGPS Correction Test is to compare GPS observed coordinates with their corresponding published GPS geodetic values. The test was carried out at the existing GPS geodetic network in Peninsular Network. An example of the layout

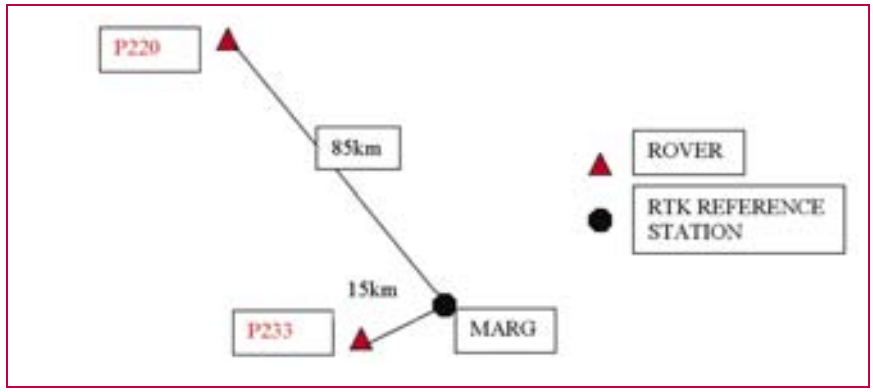


**Figure 6: DGPS Network**

**Table 3: Network Base DGPS Test Results**

| Station Name | Adjusted Coordinates | Known Coordinates | Difference (m) |
|---|---|---|---|
| **North Component** | | | |
| 1. P233 | 1° 27' 10.84805 " | 5° 12'10.85003 " | -0.059 |
| 2. P220 | 4° 52' 32.63529 " | 4° 52' 32.63501 " | 0.008 |
| **East Component** | | | |
| 1. P233 | 103° 4' 38.142713 " | 103° 4' 38.14063 " | 0.062 |
| 2. P220 | 1° 27' 47.15990 " | 101° 57' 47.15827 " | 0.049 |
| **Height Component** | | | |
| 1. P233 | 8.304 | 8.370 | -0.065 |
| 2. P220 | 93.320 | 93.282 | 0.038 |

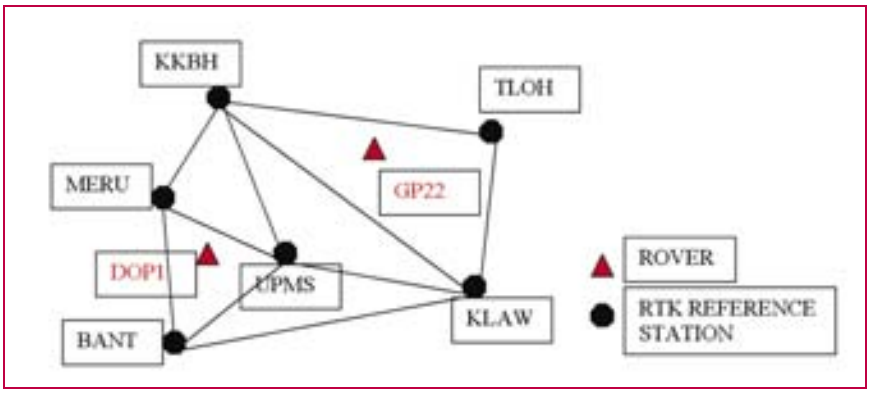


**Figure 7: Virtual RINEX GPS network test site**

**Table 4: Virtual RINEX Test Results**

| Station Name | Adjusted Coordinates | Known Coordinates | Difference (m) |
|---|---|---|---|
| **North Component** | | | |
| 1. DOP 1 | 3° 01' 29.09642 " | 3° 01' 29.09652 " | -0.002 |
| 2. GP22 | 3° 29' 47.69166 " | 1° 27' 47.69176 " | -0.002 |
| **East Component** | | | |
| 1. DOP 1 | 101° 26' 44.87642 " | 101° 26' 44.87652 " | -0.002 |
| 2. GP22 | 102° 23' 56.20633 " | 102° 23' 56.20651 " | -0.005 |
| **Height Component** | | | |
| 1. DOP 1 | 61.238 | 61.123 | 0.115 |
| 2. GP22 | 49.371 | 49.261 | 0.110 |

of the network test site is shown in Figure 6.

b. The MARG (Marang) Reference Station in Terengganu is used for the test. The test was carried out using Network Base Differential GPS (DGPS) technique with 5 sessions of observation (consisting of 10 measurements in each session) on 2 GPS receivers.
c. Two dual frequency GPS receivers were used in the test. The observation criteria applied was similar to the test (case study for high accuracy VRS correction test).
d. The final observed coordinates values as mentioned in table 3 were the results of the average of the whole set of observations.
e. The results show that the accuracies in the horizontal and height component were between 1 to 6 cm and 3 to 6 cm respectively. It also shows that for areas within 30 km from the network, the accuracies obtained were within the said levels.

## Case study for Virtual RINEX test

a. The objective of the Virtual RINEX Data Test is to compare the GPS coordinates obtained from the processing of the Virtual RINEX data with their corresponding published GPS geodetic values. The test was carried out at the existing GPS geodetic network in Peninsular Network. An example of the layout of the network test site is shown in Figure 7.
b. The Network site comprises of six (6) GPS reference stations (known stations) namely KKBH, MERU, UPMS, BANT, KLAW and TLOH. The test was carried out using GPS Static technique with 2 sessions of 10 minutes on 2 GPS receivers.
c. Two dual frequency GPS receivers were used in the test. The observation criteria applied was similar to the test (case study for high accuracy VRS correction test).
d. The comparison of the final adjusted coordinates and the published coordinates are as follows as mentioned in table 4.
e. Results show that the accuracies in the horizontal and height

component were between 1 to 2 cm and 10 cm respectively, and that for areas within 30 km from the network, the accuracies obtained were within the said levels.

## Conclusion

This paper introduces a new GPS positioning by way of RTK-GPS (VRS) using MyRTKnet services provided by DSMM. MyRTKnet has been successfully implemented with the establishment of a Network of Reference Stations equipped with GPS receiver, antenna, communication server/router, software, power supply, UPS, lightning arrestor and other accessories and equipments necessary for the full working of the station. A Control Centre has also been established - equipped with computation server, software, power supply, UPS, communication router/server, Web server and other accessories and equipment necessary for the operations of the facility. The precision estimation of positioning results surveyed by VRS has also been verified. Outcome of field experiments shows that standard deviations of 3-components of real-time positioning by VRS are about ±2 cm in horizontal and less than ±4 cm in vertical and this meets the demand for survey precision of local control point. Network DGPS solutions have also been tested with results showing that sub-meter applications were possible in areas where VRS correction are not available.

**Dato' Hamid Ali**
Director General,
Department of Survey and Mapping Malaysia (JUPEM), Malaysia
**hamidali@jupem.gov.my**

**Ahmad Fauzi Nordin**
Department of Survey and Mapping Malaysia (JUPEM), Malaysia
**fauzi@jupem.gov.my**

**Dr Samad Hj Abu**
Department of Survey and Mapping Malaysia (JUPEM), Malaysia

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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.**

### Galileo OS SIS ICD now available on-line

The information contained in the Galileo Open Service Signal In Space Interface Control Document (SIS ICD) is made available to the public by the Galileo Joint Undertaking (GJU), an undertaking jointly created by the European Commission and the European Space Agency. *www.galileoju.com*

### Galileo funding in doubt?

Under the headline 'EU stumbles over funding for Galileo', the eupolitix.com website reports that the Galileo satellite navigation project has stalled because of a disagreement over funding. It reports that the development of the project has been delayed after the EU's industrial partner, the now-single consortium that will build the system under the Concession, complained that the Commission had reneged on its promised investment. The EU budget for 2007-2013 now earmarks E900m for Galileo, although the initial pledge was for E1bn. The EC is due to issue a progress report on funding negotiations soon. *www.eupolitix.com*

### Europe 'wants Japan to join Galileo'

Europe is still keen on Japan joining the Galileo programme, according to the Japanese press, which reports that the EU and its industry are watching with keen interest to see how Japan - a heavy GPS user - eventually positions itself. 'Japan would be a very good test market for Galileo because there are many people using mobile phones and people who like gadgets,' according to Paul Flament, administrator of the Galileo Programme at the EC. He added that 'Japan is at the forefront of technology. That's why we would like to cooperate with Japan - because we know the country is important in the domain'.

Peter Grognard, MD of Septentrio Satellite Navigation NV, currently the sole supplier of Galileo receivers, acknowledges that Japan is 'years ahead' of Europe in the adoption of GPS in-car navigation and mobile phones. He commented 'I think Japan will be an excellent and early adopter of Galileo, just like it has been with GPS'. A EU delegation to Japan in December 2003, seeking their participation in the Galileo programme, was given the cold shoulder. *http://mdn.mainichi-msn.co.jp*

### LogicaCMG to develop key security features for Galileo programme

LogicaCMG announced that it has been selected for three important development contracts valued at over 20 million Euros (about £14 million) in Europe's Galileo programme. The three contracts are to develop the facilities that manage the most security sensitive elements of the programme - the Public Regulated Service Key Management Facility (PKMF), the Mission Key Management Facility (MKMF) and the Ground Control Segment Key Management Facility (GCS-KMF). *www.logicacmg.com*



## Indonesian military plane to map quake-hit areas

The Indonesian Defence Forces (TNI) have assigned a CN-235 airplane to carry out aerial photography on areas in the Yogyakarta region affected by 27 May 5.9-magnitude earthquake. The activity is aimed at making a detailed map of areas devastated by the quake.

TNI had also sent a Hercules C-130 plane carrying a TNI field medical team and three helicopters to evacuate victims. *http://news.xinhuanet.com*

## Hong-Kong to implement GIS for population by-census

The 2006 population by-census in Hong Kong will be held in July and August, and 5,000 temporary field workers will be recruited for data collection, the Census & Statistics Department said. The Commissioner for Census & Statistics Fung Hing-wang said the department will use the GIS to support the field operation, and let respondents furnish online data, and adopt Intelligent Character Recognition technology, to enhance the efficiency of data capturing. *www.news.gov.hk*

## India, Pakistan agree to conduct joint survey of Sir Creek

India and Pakistan agreed to conduct a joint survey of the Sir Creek area - a marshy area in Rann of Kutch between Gujarat and Sindh province of Pakistan, as they winded up official-level talks in New Delhi. The survey will be conducted both in creek and sea soon and the technical experts of the two countries will work out modalities, officials said. *www.hindu.com*

## Google puts street data in map of Australia

Google overnight sneaked out street mapping data for Australia and New Zealand cities within Google Maps. Google Maps offers businesses a means of overlaying their own data or statistics over detailed street maps on their web site. *http://news.google.com*

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## Product

### RT-5SW new long-range laser

A new long-range, dual-slope laser ideally suited for large job sites and agricultural land-leveling has been announced by Topcon Positioning Systems. The RT-5SW retains all of the primary benefits of the RT-5S series including five-arc-second accuracy - less than 1/32nd of an inch per 100 feet. It also features an integrated radio remote controller capable of two-way communication up to 1,000 feet. Radio communications between the remote and the base laser allows the operator to verify adjustments right from the cab of a machine. *www.topconpositioning.com*

### BAE Systems launches Version 5.3 of SOCET SET

BAE Systems announced the release of SOCET SET v5.3. This new release provides additional sensor models and new features based on automatic tie-point measurement for multi-sensor triangulation. Productivity improvements have been made throughout the SOCET SET workflow, including enhancements to SOCET for ArcGIS, Sketch, Feature Extraction, Mosaic and more. Automatic Terrain Extraction (ATE) has been improved with enhancements for bare-earth and reflected surface processing using back-matching and multi-pair matching. *www.socetset.com*

### Leica Geosystems launches Leica fieldPro

Leica fieldPro, a mobile CAD software, is the on-site and on-demand field solution for Surveying, Architecture, Engineering and Construction (AEC). fieldPro works seamlessly together with Leica Geosystems sensors, such as TPS, GPS and Leica DISTO plus, allowing users to create and visualize 2D drawings or 3D CAD models of any site in real time. With Leica fieldPro all tasks can be completed on site with no site revisits or rework. Office work is significantly reduced and productivity improved.

Leica Geosystems has also announced the introduction of Leica ScanStation, the first 3D laser scanner with four "core" total station features, offering easier operation, increased field & office productivity, and greater flexibility for as-built and topographical surveys. *www.leica-geosystems.com*

### Blue Marble Geographics' GeoObjects® 4.1

Blue Marble Geographics announces the release of GeoObjects® 4.1, a leading map display tool kit for GIS developers. Blue Marble, known for their coordinate conversion technology, is also the creator of industry leading map display, image reprojection, referencing, and map file translation technology. *www.bluemarblegeo.com*

### Total Station used at athletic meetings

Speed and precision are required when the top international athletic stars are competing for millimetres in heights and lengths. Leica Geosystems' length measuring technology is based on fine precision distance and angle measuring technology. Within just 1 to 2 seconds, the highly-precise laser beam transmitted by the Total Station, can calculate, to within a millimetre, the length of a throw or jump or the height of a pole vault. According to IAAF regulations, this reading is then rounded down to the centimetre and broadcast to the Stadium's spectators via the large results board.

### South African Track & Trace service launched.

KCS BV, hardware developer and manufacturer of TraceME, and ATsence BV, software developer and supplier of Track and Trace solutions, are announcing the launch of a tracking and tracing service for South Africa.

The past three years, TraceME has proved to be a reliable unit for tracking & tracing cars, boats, portable equipment, etc. all around the world by GPS and GPRS. Its small size makes it easy to install and many devices, like a camera, can be monitored or controlled. With Locate., the web based solution developed by ATsence BV, units are clearly displayed on the map of South Africa. For consumers a Lite version is available. The professional applications are available in the Basic, Plus and Pro versions, each revealing more options and possibilities.

### Microsoft releases MapPoint 2006

Microsoft Corp. announced the availability of MapPoint® 2006, a business mapping software. MapPoint 2006 can help customers improve decision-making capabilities and increase new business opportunities through the use of maps and geographical information, enabling better analysis, visualization and communication of business information. It also enhances its usefulness for mobile information workers by adding rich new GPS integration and driver guidance capabilities so that users can make the most out of time spent away from the office. *www.microsoft.com*

## u-blox launches AssistNowT A-GPS Service Framework

u-blox AG, a leading GPS technology and solution provider has AssistNowT, a complete Assisted GPS ("A-GPS") service package that brings instant positioning to any u-blox GPS-enabled device with mobile phone connectivity. The new technology cuts a GPS receiver's Time To First Fix ("TTFF") to seconds by providing the receiver with assistance data that practically eliminates download times of data originating from the satellites. *www.u-blox.com*

# Business

## Trimble opens office in India

Trimble is strengthening its local commitment by opening an office in India to better meet the needs of the region. Trimble Navigation India Pvt Ltd., located in Gurgaon, will be the primary base for sales and support of all survey and construction as well as mapping and GIS solutions for the country. "The opening of the Gurgaon office is an important extension of our presence in India and the Asia Pacific region," said Christian Knoll, Trimble's Engineering & Construction regional sales manager for India. "We see this as an opportunity to better service our customers to assist in the modernization drive taking place." *www.trimble.com*

## Personal navigation solution to reach 12 million by 2009

A new research report from the analysis firm Berg Insight forecasts that shipments of handset based personal navigation solutions in Europe and the US will reach 12 million units by 2009. The year 2005 marked the first successful marriage of cellular and navigation technologies, resulting in shipments of around 1 million on-board and off-board systems, mainly in the fourth quarter. Supported by the phenomenal growth recorded in the PND segment, handset based personal navigation solutions are expected to grow by 86 percent year-on-year. *johan.fagerberg@berginsight.com*

## Geospatial market in India to touch USD 613 million

Growth in the use of spatial technologies based on maps and satellite imageries has secured acceptance for geospatial technology in India as an effective decision-making tool. Many government agencies have now realised that this technology can provide them the much-needed tool to address the ever increasing demand for data availability. The figures for 2005 is Rs 10 crore (USD 2.1 million) while it will touch Rs 53 crore (USD 11.5 million) by 2010. *www.business-standard.com*

## Trimble equips Polish Government Agency with GPS

Trimble announced that it has supplied 271 GeoXT™ rugged GPS handheld receivers, part of the GeoExplorer® series, to Poland's Plant Health and Seed Inspection Services (PHSIS), a national government agency. This purchase follows an earlier sale of 156 GeoExplorer units to Poland's agency for Restructuring and Modernization of Agriculture in early 2005. *www.trimble.com*

## MapInfo introduces new location intelligence application for IBM

MapInfo Corporation announced that IBM has selected MapInfo technology to power the new Prospecting portlet in IBM's Core Life Solution for the insurance industry. The MapInfo Prospecting portlet enables insurance agents to identify and locate target customers based on neighbourhood demographic, lifestyle and consumption patterns, helping increase sales and market share. *www.mapinfo.com*

## CSI Wireless Q1 Revenues Increase 59%

CSI Wireless Inc., a designer and manufacturer of advanced GPS products, reported a 59% increase in revenues for the first quarter ended March 31, 2006, as Hemisphere GPS revenue reached $15.5 million. As a result of selling its Fixed Wireless Telephone business, CSI recorded an impairment in its goodwill totaling $8 million, resulting in a net loss of $9.2 million, or ($0.20) per share for the first quarter. *www.csi-wireless.com*

## PCI Geomatics partners with TGIS Technologies

Geomatics has announced the signing of a strategic distributor partnership with TGIS Technologies Inc. The agreement will allow PCI Geomatics to market, distribute, and sell the TGIS real-time GeoConference™ Software. TGIS Technologies built GeoConference to allow users to hold Internet teleconferences based on multi-source geospatial information. This unique solution allows groups to capture, preserve, and reuse geographic information, track and coordinate resources and interventions, and transmit geospatial data in real-time.

## Lockheed Martin and EADS Astrium to team on future GNSS

Lockheed Martin and EADS Astrium announced that they have signed a teaming agreement to ensure interoperability of the GPS III and the European Galileo Satellite Navigation programmes – the world's two most important upcoming satellite navigation systems. The companies intend to perform systems engineering and technical assistance tasks for each other in the areas of interoperability, integrity and optimisation of joint constellation performance. *www.lockheedmartin.com*

## Navigate with Garmin StreetPilot 2820

Garmin International Inchas announced the StreetPilot 2820, a premium automotive and motorcycle navigation device for customers, as well as a configurable platform for Garmin's growing list of OEM partners. The StreetPilot 2820 builds upon the success of the StreetPilot 2700 series, and also incorporates Bluetooth wireless connectivity and a hands-free calling interface. *www.garmin.com*

## Tele Atlas' voice enabled maps

Tele Atlas has announced that its phonetic data is now integrated in the newly-available Pioneer AVIC Z1 model in-car navigation and TomTom 910 portable navigation systems. Tele Atlas' phonetic data increases the quality of speech technology used in map-based applications by providing more precise pronunciations of location and directional information.

The phonetic data, critical in hands-free environments and created by Tele Atlas' own team of linguists, is the most complete available. It includes street and sign name data, administrative information for country, state, county, city and municipality levels, and points of interest in a range of pronunciations covering more than 10 European and North American languages. *www.teleatlas.com*

## Telcontar adds China map data

Telcontar, the supplier of software platforms and services for the location-based services (LBS) market, announced the launch of its Drill Down Server (DDS) 4.1. The newest version of the LBS industry's most widely deployed geospatial software platform adds China map data and a host of customized performance enhancements that enable Telcontar customers to deploy dynamic location-enhanced applications that meet the region-specific needs of China's burgeoning market. *www.telcontar.com*

## Stockholm subway implements indoor LBS platform

Cisco Systems has announced a collaboration with software provider Appear Networks to deliver an Integrated Location Services Solution for the Stockholm Subway, delivering personalised, real-time information to users in underground stations, anywhere across the Wi-Fi network.

Based on contextual information such as time of day, job role, and current physical location, the solution is able to access the right information, which is interpreted and pushed out in real time to the right users, and to the right location. *http://newsroom.cisco.com*

## Scottish City to pioneer personalized wireless information

Dundee moved a step closer to becoming Scotland's city of wireless innovation, with the announcement of a partnership between the University of Abertay Dundee and LastMile Communications, the British company pioneering a wireless delivery platform using WiFi. Under the agreement, the Abertay campus will become a test bed for LastMile's state-of-the-art node-based wireless information system. The technology offers end user-focused content to mobile devices on demand, and tailored precisely to their location. *www.lastmilecoms.com*

## Mapping software to power Locator Web Product

ESRI has announced that Xionetic Technologies has selected ESRI's RouteMAP IMS software to power its new store locator service. Xionetic is using RouteMAP IMS to create Locator Web, a Web-based hosting solution that allows companies including Kohler, North Face and Sketchers to easily add a dealer or store locator and mapping and driving direction functionality to their Web sites without hosting the services themselves. Xionetic hosts more than 170 customers' sites and plans to use RouteMAP IMS to rapidly grow this in the coming months. *www.esri.com*



## China to survey the Great Wall

The Great Wall resource investigation has kicked off officially in Hebei Province. It is the first time for China to make precise measurement and accurate survey on the Great Wall with comprehensive investigation and mapping skills, which will be undertaken for several years.

China has launched the nationwide investigation of the Great Wall for twice since the establishment of the new China. In the mid-1950s, China did primary investigation on the age and distribution of the Great Wall with the help of the national cultural relic survey, and the second-time investigation was undertaken in the 1980s. *http://news.xinhuanet.com*

## US policy shift pushes back plans for new GPS satellites

Long-pending Pentagon plans to solicit bids for a new generation of significantly enhanced, more-powerful GPS have been delayed at least a year, partly due to Air Force policy changes that stress less-risky, incremental acquisition of new space hardware, according to military and industry officials. On the drawing boards since the late 1990s and previously projected to be put out for bid this year, the so-called GPS III programme remains in limbo as Air Force and Pentagon brass mull its design and timing. *http://online.wsj.com*

## Telcordia turns Ford Car into wireless communication center

In collaboration with Ford Motor Company, Telcordia revealed a completely wireless-enabled Ford Five Hundred sedan. This latest development from Telcordia's world-renown Advanced Technology organization demonstrates Telcordia's innovative approach to leveraging technology and capitalizing on new market opportunities as the lines between some of the consumer's most treasured assets -- cars and communications -- blur. *www.telcordia.com*

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# A new move(ment)

India comes out with guidelines for implementing its National Map Policy that was announced last year. We present guidelines and observations by Professor George Cho and Professor JG Krishnayya. We will continue this discussion in the next issue

## 1. Background

The Central Government announced the National Map Policy (NMP) on 19th May 2005. The NMP document authorizes Survey of India (SOI) to issue detailed guidelines on the implementation of the NMP. These guidelines are issued in the light of the above cited authorization. The guidelines are clarificatory in nature and does not create any new rights nor abridge any existing rights which are enforceable in courts of law.

## 2. Information on Maps and guidance of indentors

a) All up-to-date information on SOI maps shall be available at the various offices, map sales counters and Geospatial Data Centres (GDC) under the SOI. The information shall also be available on Survey of India website www.surveyofindia.gov.in created and maintained by the SOI. The information provided inter alia includes all relevant details of maps such as scale, information content, date of data capture, price, mode of data dissemination whether MOD clearance available for issue as Open Series Map (OSM) etc. The website also has a search engine by which the exact sheet number of a given locality can be traced by giving elementary details like name of district or any other prominent feature. SOI offices may be contacted for further information on OSMs.

b) The lay out of OSM sheets on UTM projection and WGS 84 datum is shown in Annexure 'A'. The annexure also shows the incidence of the existing topographical series on the OSM series.

c) Data content: Approved data content of OSMs is given in Annexure 'B'.

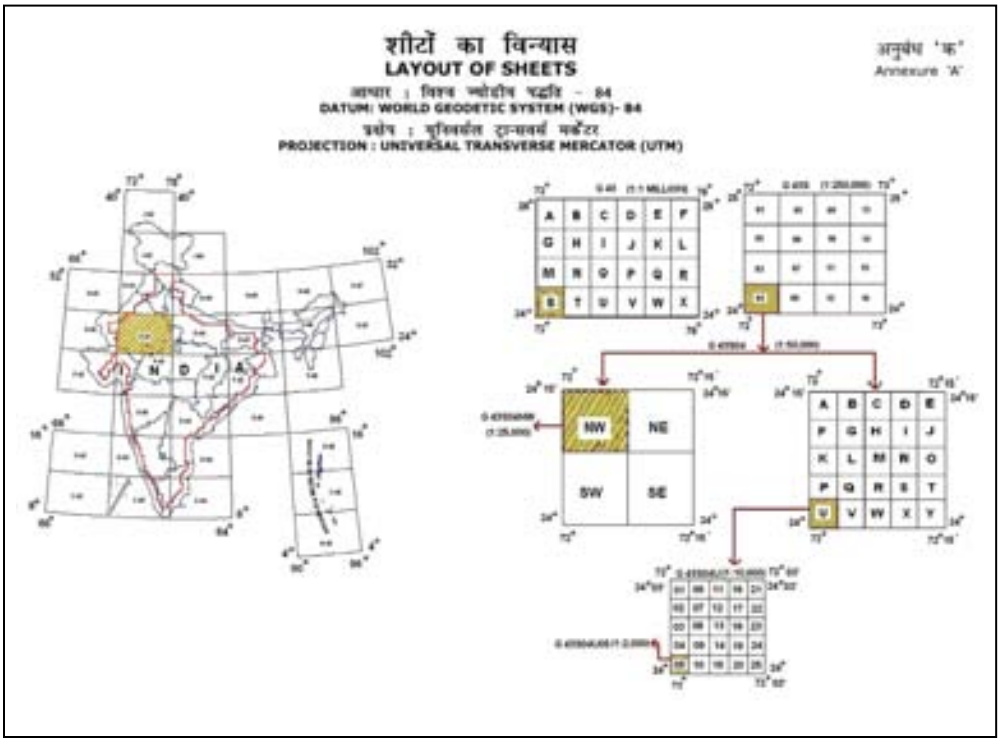
d) Export of all maps/digital data in 1: 250K and larger scales through any means is prohibited vide Ministry of Finance (Department of Revenue) Notification No. 118-Cus./F.No.21/5/62-Cus. I/VIII dt. 4th May 1963. Digital Topograhical data will be licensed to only Indian individuals, organisations, firms or companies.

## 3. Sales/ Data Dissemination:

(a) Analogue/Paper Maps: of all scales shall be made available from Survey of India (SOI) offices and Map Sales Counters on payment at prices as may be fixed by SOI from time to time. The list of such outlets, their addresses with telephone numbers shall be made available in the website www.surveyofindia.gov.in. These maps can also be sold by any retailer. Digitisation of SOI analogue/paper maps is strictly forbidden.

(b) Map Transaction Registry (MTR): As stipulated in the National Map Policy, Survey of India will establish an on-line MTR for recording of all transactions relating to digital maps. Each user will be allotted a unique user ID and each transaction with a unique transaction ID. For all future correspondence, this user ID and Transaction ID should be referred.

(c) Digital Maps: include both Raster and Vector forms. The ownership of all digital data vests solely with SOI and will be given only under licence against indent and on payment. Unauthorised copying and distribution of SOI digital



data are strictly prohibited. All licenses will be issued through the Map Transaction Registry (MTR). The format of the licences is available in SOI web site www.surveyofindia.gov.in. The indents may be made in the prescribed proforma (appended as form A).

## 4. Licensing of Digital Maps:

Digital data will be available in single/ multiple/ commercial licensing for general use, value addition and marketing. All digital maps will be provided with encryptions/mechanisms which may corrupt the data while copying unauthorisedly or while attempting the same. Every such attempt shall attract criminal and civil liability from the user without prejudice to the corruption of data or software/hardware for which the SOI will not be liable. SOI digital data will be licensed based on usage. Following are the categories:

- Digital Licence
- Publishing Licence
- Internet Licence
- Media Licence
- Value addition Licence

Terms and conditions governing each of the licence is available in SOI web site www.surveyofindia.gov.in.

## 5. Procedure for value added products

Inasmuch as the NMP is aimed at encouraging a flourishing geospatial industry and related knowledge services, there is much expectation from the industry to do value additions to the products of SOI. SOI encourages individuals/ industry to do value addition. Intending value adders will submit a business model indicating the products to be generated and marketing strategy and also execute a Memorandum of Agreement (MOA) with SOI.

## 6. Pricing of various products:

(i) The SOI shall notify from time to time the price list of its standard products.

(ii) The prices are subject to revision from time to time.

(iii) An indentor has to pay the amount at the rate prevailing on the date of supply unless the indenter has already paid at the earlier rates. In other words, the indenter will not be eligible for supply on payment on the plea that the rates prevailing on the date of indent were lower.

(iv) The SOI reserves its right for differential pricing, such as concessions to Universities, Research organizations, deserving NGO's on the basis of predetermined policies, different prices between single and multiple user licenses etc.

## 7 e- Payment:

Digital maps, on following the procedure, will be made available on

**CONTENTS OF OSM** **Annexure 'B'**

| S.N. | CATEGORY/LAYER | | SUB DETAILS |
|---|---|---|---|
| 1. | GENERAL | | Latitude/Longitude<br>Name of State/District/Administrative index<br>Topo sheet Number /Year of Survey/Edition<br>No./Index to topo sheets<br>Magnetic variation from true North direction<br>Map reference<br>Bar scale/Representative Factor |
| 2. | ADMINISTRATIVE BOUNDARIES | Names<br>Boundary<br>Boundary Pillars | Administrative/Locality or tribal<br>International to village, Forest,<br>all boundary pillars, village trijunctions |
| 3. | COMMUNICATIONS/ ROADS | Roads<br>Tracks<br>Railways<br>Embankments<br>Other Lines | All Roads<br>All Tracks, pass, footpath<br>All gauges with stations, tunnels<br>Light railways or tramway, ,<br>All embankments, Road/rail/tank |
| 4. | HYDROLOGY | Stream/Canals<br>Dams<br>Rivers & Banks<br>Wells, Water Features | All streams/canals<br>All earthwork dams<br>All rivers with details, banks, islands<br>All wells/tube wells/springs<br>All Tanks (excluding overhead tanks),<br>Lightship, buoys, anchorages |
| 5. | SETTLEMENT/ CULTURAL DETAILS | Towns or Villages<br>Offices<br>Settlements | Village inhabited, deserted and forts<br>Huts, Tower, Antiquities<br>Religious places, tombs/grave<br>All post/telegraphic/Police stations hut<br>All Bungalows |
| 6. | TRANSMISSION LINE | | |
| 7. | RELIEF/ HYPSOGRAPHY | Contours<br>Sand Features<br>Ice Forms<br>Heights<br>Benchmarks | Contours with sub features<br>All sand features<br>Ice forms (all features)<br>Spot height, Approximate height<br>Bench marks (Geodetic tertiary, canal) |
| 8. | VEGETATION | Plantations, Trees | All trees, Vine on trellis, grass, scrub. |
| 9. | FOREST | | Reserved/Protected |

* Contours & heights will not be available in restricted zones as per MOD's instructions.

variety of media like Compact Disks (CDs), DVD etc. Maps on 1:1M and smaller scale on compressed JPEG format will be available for download against online submission of licence agreement and on e-payment. The self-guide provided in www.surveyofindia.gov.in shall enable an indentor to make e-payment and download the requisite maps.

## 8. Settlement of Disputes:

In case any dispute arises on the applicability or interpretation of these guidelines between the SOI and any other person, the matter shall be referred to the Secretary, Department of Science & Technology, Government of India, whose decision shall be binding on both the parties.

## 9. Applicability of previous instructions:

The Ministry of Defence has from time to time issued detailed guidelines on various aspects of map access and use. These instructions shall continue to hold good but for the modifications cited in the NMP.

## 10. General:

(i) Copyrights of all SOI maps (both digital and analogue) vest exclusively with the SOI. Any person resorting to unauthorized copying or use or attempts to do so shall make him liable to criminal and civil liability under existing laws.

(ii) While every effort will be made to ensure availability of maps of all areas containing all necessary details and with highest accuracy, SOI will not be responsible for any loss caused to any person on account of failure on any of the above factors or any other reason.

(iii) The SOI reserves the right to add, delete, modify amend any or all of these guidelines without notice and without assigning any reason.

## MTR sounds to be too rigid

**Prof J G Kri hnayya**
Director,
Systems Research Institute, Pune, India
**geoconcept@vsnl.com**

It is good that SoI has been quick to release a comprehensive statement on the manner in which digital maps will be made available to the Indian mapping community.

I assume that these Guidelines will be modified as the real-world experience suggests where changes will improve communication, increase speed, simplify operations. This kind of openness to the possibility of change is always needed.

Committing the SoI to have available all information at all SoI offices, and on the website is a good thing.

Committing the SoI to UTM and WGS-84 - international standards - is also really a great improvement.

### Data Content

Here is where one has to raise questions again about the elimination of all height information from OSM maps. We would appeal again to the SoI and the MoD that they consider the purposes for which digital maps are needed and are to be used in India.

For the foreseeable future, the most important geographic problem facing the country is (a) Urban expansion and (b) Global Warming and related problems, including water availability. Of the two (b) is more serious, although (a) is more urgent. Particularly where we are tracking snow-melt, and snow-pack, height information is very very important. As water becomes ever more a valuable resource, flow information, flow possibilities and therefore height information becomes more and more important. It is very obvious to any urban planner that height information in and around settlements is essential for rational planning. For these - and many other - reasons, we would appeal to the MoD to relax their veto of height information. The international strategic situation, the types of conflicts that India is likely to be in, also suggest that 1-5-10 meter contours will not be important for our defence at a time when satellite-derived information is freely available to potential enemies.

### MTR

The concept of the Map Transaction Register which enables IT-based total control over the distribution of maps, sounds to me to be too rigid for the culture of the Indian subcontinent. India and Indians do not have the discipline in our culture to sustain such a well-defined methodology (and I say that without criticising our undisciplined, untrammelled style of living). (I note, by the way, that the Guidelines apparently make it illegal for any body, individual or corporate, who is not “Indian” to indent for or to posses an SoI digital map.) It is not clear to me whether this is entirely realistic.

### Pricing

The idea of concessional pricing for NGOs, for Educational institutions, for Research is a good idea, as is the separation of Single-copy, Value-added, Commercial, etc. “markets” - and therefore licensing regimes for maps.

However, I wonder whether everyone who would like to make amendations to SoI maps before using/reselling them in a niche market would be able to create a business plan on the basis of which an MoA could be drawn up. This would tend to restrict access to maps to larger organisations, I fear. This approach seems to be patterned on that of The Ordnance Survey (UK), where the situation is quite different from India’s, so that I feel such a practise could well be held up for a decade or so until the Indian digitil-map-market has matured more.

**Send your comments on national map policy at**

**talktous@mycoordinates.org**

# Glacial progress

**Prof George Cho**
University of Canberra, Australia
**george.cho@canberra.edu.au**

The Guidelines are part of the National Map Policy (NMP) announced nearly a year ago (www.surveyofindia.gov.in). This policy authorises the Survey of India (SOI) to issue guidelines for the implementation of the NMP and in particular the use of SOI products – analogue and digital. This commentary makes reference to the paragraphs in the Guidelines. The Guidelines consist of four short unpaginated pages, two annexes and a Digital Products Indent Form.

Paragraph 1 provides the background to the NMP at 19th of May 2005 and the origins of the Guidelines.

In para 2(a) it is mentioned that up-to-date information on SOI maps will be available everywhere SOI products are handled. A web site address is given for Internet transactions.

## Export

More significantly para 2(c ) pertains to approved data content of all Open Series Maps. Further details are outlined in Annex 'B'. However, mention is made that "export of all maps/digital data in 1:250K and larger scales through any means is prohibited". Users might ask the question of the meaning of "export". Any local company may export derived products, albeit, based on SOI information; would this be permissible?

## Licence

The next sentence states that "topographical data will be licensed to only Indian individuals, organisations, firms or companies". The meaning of licence is not defined. Is this a licence to use, a licence to copy, a licence to re-purpose? Further only Indian individuals may be licensed. It is unclear whether this includes those with dual citizenships, Indians but non-citizens, and Indians (presumably citizens).

## Digitigation

On para 3 the heading on Sales/Data Dissemination contains three sub-sections. In particular sub-para (a) prohibits the "digitisation of SOI analogue/paper maps". The Guidelines do not state whether these are in raster or vector form and is silent about whether scanning the whole map sheet as one image is permissible.

## MTR

Para 3(b) refers to a map transaction registry (MTR) presumably a record of all sales and licensing transactions undertaken. Users will gain a user ID and a transaction ID – presumably for future use and tracing.

## Copying

Para 3 (c) states that digital maps include both raster and vector forms. The claim to ownership by SOI is made here on all digital data and will only be given under licence against indent and payment. This appears reasonable. But then the Guidelines goes on to state that "unauthorised copying and distribution of SOI digital data are strictly prohibited". It is unclear what this copying means because once an agency is licensed by SOI it should be able to make copies within limits of the license. How, for instance, could a company operate if it cannot copy its data for its subsidiary or branches. This statement also begs the question as to whether authorised copying is permissible. Everything seemingly will hinge on the words and terms of the licence that has been provided by SOI.

## Formats of licence

In this paragraph the Guidelines discuss the format of the licences and point to its availability on the SOI website. The SOI website provides four main types of licences – media, publishing, digital and Internet. Each of these are pdf documents and are quite comprehensive. Among others, the licences in general deal with the scope and terms of the licence agreements (in terms of definition, licence, licensee's obligations); SOI liabilities, Intellectual Property Rights (IPR), Annual licence fee, Changes to the licence, Audit and inspection rights, Transferring rights and responsibilities, Arbitration, Relationships, Force majeure, Termination, Non-Waiver, Governing law and Jurisdiction.

## Licensing of Digital Maps

Para 4 deals with Licensing of Digital Maps. While the licensing of the digital data provide for general use, value adding and marketing, there is a statement which warns that encryption technology has been incorporated into the digital products. The original data will be destroyed if the data were subject to copying activities. Criminal and civil liability attach to these unauthorised activities. The issue here is therefore how any company can make use of the data in order to value add to it or use it for marketing purposes without being given the decryption key to unlock the data. This makes the task of re-use, re-purposing the digital data extremely cumbersome and difficult – which presumably is the object of the policy. No details are given as to which parts of the criminal code or civil law would swing into play once someone is detected infringing the agreement.

The format for the "value addition" [sic] licence is not given on the SOI website.

In presentation terms it is believed that it may be better placed to have the various licenses given here as annexes rather than having users refer to the SOI website. Doing so would ease the task of adopting its use more readily.

## Value added products

Para 5 deals with Procedure for Value added products. This paragraph contains a good suggestion in the sense of attempting to encourage the geospatial industry and related knowledge services (as well as the location based service industries). The requirement that a business case be mounted under a memorandum of understanding is something new. This innovative requirement should be applauded and should be welcomed by companies using SOI. The key to success in growing

the geospatial industry is one of a partnership rather than a structured hierarchical one of giver and taker.

### Pricing

Para 6 spells out the pricing scheme of various products while para 7 gives details on e-Payments. Again this is a good initiative but could be open to abuse in several ways, for instance, non-citizens hiding behind nom-de-guerre in credit cards issued by Indian financial institutions.

### Settlement of disputes

Para 8 is about the settlement of disputes while para 9 is about the applicability of previous instructions. The final para 10 is about "copyrights of all SOI maps". In reality, this should refer to the more generic intellectual property right. There appears to be a gender bias where a statement begins with "any person" and concludes with "shall make him liable to" criminal and civil liability. Whilst there is a disclaimer in sub-para (ii) (which strictly to be pedantic should be alphabetized rather than numbered) it does not state to what accuracy standards the details are compared with and whether such a disclaimer on possible loss is sufficiently water-tight against possible litigation.

Annex A gives the layout of the sheets under the SOI system of mapping. Annex B gives the contents of the open series maps. These look like the beginnings of metadata headers for digital files of geospatial information. But on closer inspection, the content are of insufficient detail for more universal use or for international comparability.

### Data content

Form A is the SOI Digital Products Indent Form – a 3-paged form for use if one wishes to purchase or get a licence for SOI products. However, such a form lacks a warning on possible civil and criminal liability for entering false information and there is no disclaimer here about the accuracy of maps supplied and the limitation of liability from action for loss or damage incurred as a result of its use.

Overall, an interesting development but reflects the glacial progress into the digital age of a heavy bureaucracy as well as the reality of the information technology revolution in changing the nature of maps in general. however, these Guidelines compare well with the more generic ones in use by Geosciences Australia and Australian government policies Geosciences Australia Digital data licensing and sales policy at http://www.ga.gov.au/nmd/products/purchasing/licencing.htm; and Australian government spatial data policies and guidelines at http://www.osdm.gov.au/osdm/policy.html).

## NEWSBRIEF - REMOTE SENSING

### Indian Regional Navigation Satellite System approved

The Union Cabinet of India gave its approval to undertake the development and deployment of an Indian Regional Navigation Satellite System (IRNSS) at a cost of Rs. 1420 crores (USD 312 million), with a foreign exchange component of Rs. 1100.00 crores (USD 246 million) excluding launch services. IRNSS will provide an independent, indigenously developed constellation of satellites to provide satellite-based position, navigation and timing service for critical national applications. *http://pib.nic.in*

### Indian Air Force says Google satellite images not a threat

The satellite images of the country's defence installation displayed on the Google Earth website do not pose a threat to the Indian Air Force, the Air Chief Marshal S P Tyagi said. "Google is not a threat to the IAF. Showing defence establishments is not a big deal. I can also see others' (security set-up using the same technology). We live in a transparent world," he told reporters. Google Earth had began displaying the images only recently "but I have been seeing them for the last 20 years", Tyagi said. *http://timesofindia.indiatimes.com*

### China to launch satellites for lunar surveying

China will launch high-resolution satellites to conduct surveying and mapping of the moon in upcoming five years, the People's Daily reported. The satellites will probe the moon's surface, physiognomy, landform and geological structure to draw a three-dimensional map of high precision, the report says. *http://news.xinhuanet.com*

### World fire maps now available online in near real time

For a decade now, ESA (European Space Agency) satellites have been continuously surveying fires burning across the Earth's surface. Worldwide fire maps based on this data are now available to users online in near-real time through ESA's ATSR World Fire Atlas. The ATSR World Fire Atlas (WFA) – the first multi-year global fire atlas ever developed – provides data approximately six hours after acquisition and represents an important scientific resource because fire is a major agent of environmental change *www.esa.int*

### Commercial Remote Sensing satellite market in US stabilizing

In a new study, "The Market for Civil & Commercial Remote Sensing Satellites," Forecast International is projecting deliveries of approximately 139 imaging satellites worth $16.3 billion over the next 10 years. The first half of the period will be more active than the second, with 97 spacecraft slated for production within the next five years. Despite the ever-growing list of remote sensing spacecraft destined for orbit during the next 10 years, very few new players are expected to enter the commercial operator market. *www.spacedaily.com*

# "We listen to our end users"

**Christian Knoll**, Trimble Navigation India Pvt Ltd on challenges of Indian market

## Tell us about Trimble India

Trimble Navigation India Pvt Ltd is a 100% subsidiary of Trimble Navigation Ltd, USA. The India office was established at the end of 2005 and was officially opened on 16, May 2006. It is an important extension of Trimble's presence in India and the Asia Pacific region. Our objective is to better service our customers and distribution network to assist in the modernization drive taking place in the country.

## What is the focus of Trimble's Engineering & Construction Group?

Trimble's Engineering and Construction Group focuses on the development of technology and solutions in the core areas of surveying, construction and network infrastructure. We offer integrated positioning solutions and systems that are used from concept to completion to streamline jobs and improve productivity.

## What factors do you keep in mind when launching a product?

We listen to our end users, so that we can develop solutions that fit their needs. With this in mind, Trimble creates products that are designed to be accurate and easy-to-use. Each new product also works seamlessly with other Trimble products, so that our customers can employ our complete Integrated Surveying solution to improve productivity on the job site.

Additionally, when launching new products, Trimble is committed to educating and training our distributors and end users, to ensure that end user benefits and correct operation are maximized. The positive feedback we receive after each event indicates that this method of product introduction is extremely well received by all involved.

## How is Trimble different?

Trimble offers complete solutions for the Engineering and Construction industry—hardware, software and services—not just products. With our in-depth market understanding, and personnel with industry expertise, we develop unique and innovative solutions specific to each market segment we serve.

## What opportunities and challenges do you see in the India market?

The opportunities and challenges offered by the India market are not entirely unique. Similar opportunities are shared by other emerging markets, and a global opportunity is therefore arising. Lessons learned in the exciting India region can be leveraged across other emerging markets, and can influence Trimble management practices.

## The developing world is a price-sensitive market. Comments?

Price is an important factor in developing markets. However, success in these regions is not about lowering price.

Indian customers are extremely value conscious, so our approach involves understanding and managing the price-performance relationship as well as clearly explaining return on their investment.

## How do you approach an evolving market like India?

Emerging markets such as India allow us to challenge conventional wisdom when it comes to strategy. For example, distribution systems are critical in India. In fact, innovations in distribution are as critical as product and process innovations.

## There is a perception that vendors oversell instead of educating. Comments?

Many of our customers are first-time users, so Trimble products are easy to use and have a short learning curve. As mentioned earlier, Trimble invests significantly in educating customers on the use and benefits of our products and services.

Christian Knoll, Country Manager Trimble Navigation India Pvt Ltd., prior to this he was posted at the Trimble European Headquarters in Frankfurt from 2002 – 2006, responsible for European OEM Sales.

He graduated from University in Munich, Germany, with a Degree in Mechanical Engineering and Business Administration.

He received further Management Education from IIM-Ahmedabad and has successfully launched MNC's in India before joining Trimble.
*christian_knoll@trimble.com*

# Space-based positioning system with no on-board atomic clocks

An overview of the architecture and its advantages and disadvantages over the classic GPS scheme

**Fabrizio Tappero, Andrew Dempster, Toshiaki Iwata**

The Japanese Quasi-Zenith Satellite System (QZSS) represents an innovative multi-service satellite system able to provide positioning for mobile users over Eastern Asia and Australasia. The integration of the QZSS with the present GPS and the European GALILEO will improve accuracy, availability and capability over a wide area. Throughout a collaborative research program, the space technology group of AIST, Japan and the University of NSW, Australia are studying the feasibility of a revolutionary remote synchronization scheme for implementing a QZSS with no on-board atomic clocks. It basically consists of a remote synchronization scheme where the satellite on-board time reference is constantly linked to a main atomic reference located in the ground station. An up-link/down-link network provides an opportune synchronization/correction signal that keeps the master time reference and the satellite time reference in lock-step. This revolutionary system will not require on-board atomic clock, in fact satellite clocks would just act as transponders, broadcasting the very precise time broadcast from the ground station.

This new concept of positioning system is now under study through the adoption of a dedicated hardware simulator as well as software simulator tools. The following paper presents an overview of the architecture and its advantages and disadvantages over the classic GPS scheme.

## GPS satellite clocks

To provide proper positioning signals, positioning system satellites, i.e. GPS satellites, need very accurate on-board time references. In fact, in order to achieve high stability, GPS satellites adopt very precise on-board atomic clocks. In such scenario, the satellite on-board time keeping system (TKS) is responsible for the synchronization of the on-board voltage controlled crystal oscillator (VCXO) with the on-board atomic clocks. Block II/IIA satellites contain two cesium (Cs) and two rubidium (Rb) atomic clocks. Block IIR satellites contain three Rb atomic clocks. Consequently, satellites are fairly independent from ground station synchronization and, generally, only a daily time synchronization/correction is required.

When GPS was conceived, it was recognized that the most difficult technology problem facing the developers was probably the need to fly accurate timing standards insuring that all satellites' clocks remained synchronized [1]. Considering that light travels about 1 ft per ns (1X10-9 s), if the system can tolerate an error buildup caused by the on-board clocks of 5 ft, the on-board clock frequency stability should be roughly 5 ns per upload. Considering that visibility of GPS satellites, such upload can be performed every half day. Therefore the required frequency stability should be roughly (5X109)/(4X104) = 1.25 X 10-13 measured over 12 h. Such requirements can be met only by atomic clocks. GPS was born as a military-purpose application therefore, a strong independency from ground stations is certainly an important point.

## QZSS satellite clocks

Despite similarities in the GPS signals, the QZSS orbit design greatly differs from that of GPS, and if a proper location is chosen permanent QZSS satellite view can be achievable. Furthermore QZSS is a civil system with completely different basic requirements. QZSS's positioning capabilities will represent a new-generation civil GPS space augmentation system, with limited navigation capabilities. In other words, although the QZSS is seen primarily as an augmentation to GPS, without requirements or plans for it to

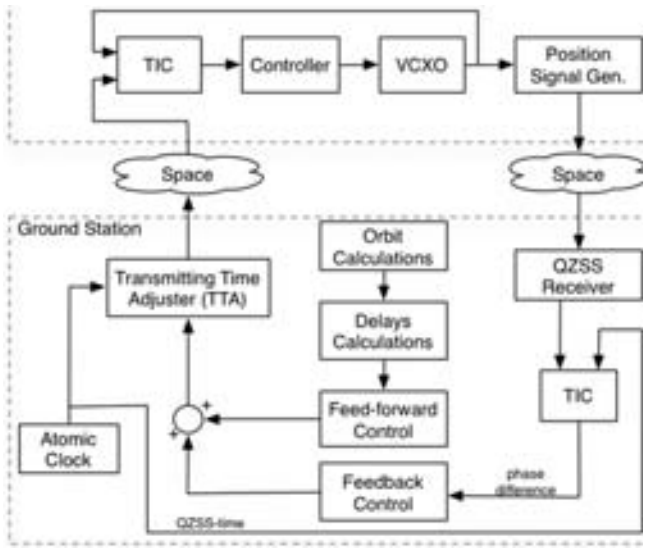



**Figure 1. Schematic of the remote synchronization system for the on-board crystal oscillator (RESSOX)**

work in standalone mode, QZSS can provide limited accuracy positioning on its own. The service also could be augmented with geostationary satellites in Japan's MTSAT Satellite-based Augmentation System (MSAS) currently under development, which features a geostationary satellite-based design similar to the U.S. Federal Aviation Administration's Wide Area Augmentation System (WAAS). Details of the QZSS orbit design and signal structure can be found in [2].

According to its original plan, QZSS satellites will be carrying two types of space-born atomic clocks; a hydrogen maser and a rubidium atomic clock. The positioning signal will be generated accordingly to these two clocks and an architecture similar to the GPS TKS will be employed.

QZSS will be also provided with a Two Way Satellite Time a Frequency Transfer, TWSTFT, scheme that will be employed to gain some fundamental knowledge of satellite atomic standard behavior in space and for other research purposes. Among them there is the R&D of a revolutionary time synchronization system that aims to study the feasibility of a no on-board atomic clock GNSS.

## No on-board atomic clock GNSS

With a research program started in the 2003, the Space Technology Group in the National Institute of Advanced Industrial Science and Technology (AIST) of Tsukuba, Japan has been studying the feasibility of a novel time synchronization system for QZSS. The novelty of this research is based on the QZSS orbit design and on its high satellite visibility. Such a peculiar feature makes possible to reconsider the classic TKS structure as a remote TKS where the main time reference (atomic clock) is located on the ground in the control station and a correction/synchronization infrastructure keeps the on-board time reference continuously synchronized. Seen in this way the novel TKS for QZSS is indeed a remote synchronization system (RSS) for the QZSS on board time reference. The feasibility of a synchronization method where one clock is in the ground and the other is flying in space is certainly a non trivial task. [3][4][5][6] are some of the numerous articles that report results of the undergoing research of the QZSS-RSS novel concept.

## Feasibility of QZSS-RSS

Theoretically, if a communication channel between satellite and ground station could be kept open, the difficulties in synchronizing the two clocks lies in knowing what the phase shift between the two clocks is and in knowing how to proper steer the remote on-board clock. Fig. 2 shows the Allan variance of the atomic reference that could be adopted at the ground station, the Allan variance of the satellite on-board clock, a space-born VCXO, and the curve that represent the requirement for a maximum 5 ft buildup error (5 ns).

If the phase shift between the on-board clock and the ground clock could be estimated within a certain accuracy, the synchronization system should correct the on-board time in order to get a total stability represented by the red time. One of the goal of the AIST project is study the feasibility of such system. One of the big issues regarding this architecture is to understand what could happen when the synchronization is lost. For instance, when QZSS satellites cross the equatorial region, ground-satellite communications have to be turned off, leaving the satellite on its own for at least 11 minutes, twice a day.

Looking at Fig. 2, it can be noticed that a VCXO on its own tends to drift much more and faster than an atomic reference. Considering 5 ft or 5 ns as the acceptable limit for the maximum buildup error caused by the on-board clock, the satellite must be resynchronized at least every 2000 s (33 minutes).

## QZSS-RSS, practical implementation

Iwata et al. [3] proposed the first concrete implementation to realize this synchronization technology for QZSS. The idea is based on the compensation of the ground station satellite delays through prediction. Fig. 1 presents a simplified schematic of the remote synchronization system for the on-board crystal oscillator (RESSOX). The precise time available at the ground station (QZSS-time) is "advanced" by means of the Transmitting Time Adjuster (TTA) and then uploaded to the satellite. Here, a PLL architecture is implemented to steer the local on-board clock, a VCXO, and keep it locked to the received signal. The output of the VCXO is used to construct the QZSS positioning signal that is then broadcast to the user. The key point is to keep the ground station clock and the on-board VCXO synchronized by controlling the TTA such that all communication delays are compensated. To do this, a double feedback and feed-forward control loop, based on orbit prediction and delay calculation, are

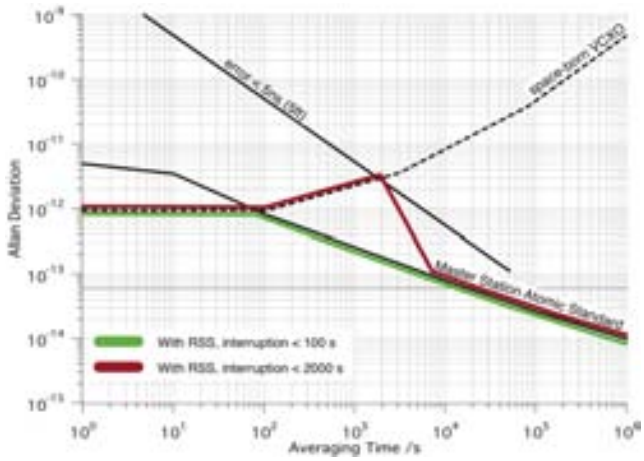



**Figure 2. Frequency stability performance for the no on-board atomic clock GNSS**

used. A detailed description of this method can be found in [3] [5].

AIST and the University of NSW are now investigating the feasibility of a second method, a method based on the TWSTFT scheme, available for QZSS. This new control method is characterized by its great simplicity and it is designed specifically for the QZSS. It does not require any on-board atomic clock and, unlike RESSOX does not require any satellite position prediction nor any delay calculation. Its architecture resembles the structure of the TKS for the classic GPS where, instead, the control voltage that drives the VCXO is processed remotely, in the ground station. Hence it has been named Remote Time Keeping System, RTKS. In [4] the TWTT method and its implementations in the QZSS are described.

### Phase shift measurement

As mentioned early, the real-time or quasi real-time determination of the phase shift between the ground station clock and the on-board clock, is a fundamental requirement for the realization of QZSS-RSS. Presently two strategies are under study. The architecture proposed in [3], being totally based on satellite position prediction and delay estimation, relies on the ability of predicting what the phase shift is. The implementation of an additional feedback that make the whole system more robust in now under study. Synchronization accuracy of the order of 4 ns are achievable for this scheme.

The second architecture, recently proposed in [4] takes advantage of the TWSTFT scheme. Now under test on board the ETS-VIII and, in the future, available for QZSS, the TWSTFT method is expected to offer accuracy of the nanosecond order at all times.

### VCXO control Algorithm

One of the key points for the realization of RSS for RESSOX is the implementation of a controller for the on-board VCXO that can combine the good short-term stability of the VCXO with the good long-term stability of the ground station atomic standard. When the synchronization information is upload-able, such controller should be able to keep the VCXO looked to the ground station clock within acceptable limits. In [6] the authors report a successful implementation of such controller where the Allan variance of the controlled VCXO is largely below the 5 ns requirements.

## Conclusions

With the opportune shrewdness, the basic idea that lies behind the QZSS-RSS could theoretically be applied to other GNSSs. The two proposed methods, [3] [4], are practical implementations of this remote synchronization concept specifically made for QZSS. Both schemes could theoretically be applicable to a world-wide GNSS, i.e. GPS or GALILEO. For such systems, all time view is not applicable and more ground stations would be necessary to guarantee the necessary synchronization update. Beside being a very interesting research topic, the idea of a GNSS with no on-board atomic clocks would offer several advantages in term of satellite cost, life expectancy and satellite power consumption. This concept could be advantageously applicable to Low Earth Orbit, LEO, positioning systems, [7], where satellite weight is clearly a critical issue.

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**Fabrizio Tappero**
School of Surveying & Spatial Information Systems, The University of New South Wales, Sydney, Australia
**f.tappero@student.unsw.edu.au**



**Andrew Dempster,**
Director of Research, School of Surveying & Spatial Information Systems, The University of New South Wales, Sydney, Australia
**a.dempster@unsw.edu.au**



**Toshiaki Iwata**
National Institute of Advanced Industrial Science and Technology (AIST) Tsukuba,Japan
**totty.iwata@aist.go.jp**

# KCS TraceME

## GPS/GPRS/GSM Module

Distributors welcome!

**The KCS TraceME/TrackME GPRS/GPS Module enables you to remotely track & trace a variety of objects, e.g. cars, trucks, containers or ships. Its small, lightweight aluminum design makes it easy to install and together with the extended position logging, it's ideal for use in fleet management, anti-theft and M2M applications.**
**Furthermore, the numerous I/O connections allow monitoring and control of a range of external hardware. For surveillance and security purposes, a tiny camera is available, so you can see what's going on at a glance... anywhere, anytime!**

## Key Features

- Extremely small and lightweight
- Ultra low power consumption
  - Car/truck battery
  - Solar panel with small battery
  - Power supply
- Excellent GPS accuracy
  - Autonomous, MS-A or MS Assisted A-GPS
- Versatile interfacing
  - More than 25 I/O lines
- Maximum flexibility
  - Remotely configurable to fit any application
- Integrated SIM card reader
- Wide operating temperature range
- Ruggedized aluminum enclosure designed for rough environments
- Fully EMI shielded

KCS BV
Kuipershaven 22
NL-3311 AL Dordrecht
Fax: +31-20 5248130

## Product Summary

Equipped with a state-of-the-art GPS receiver, the KCS TraceME/TrackME Module provides reliable and accurate navigational data. All communication is handled rapidly and effectively by a GPRS/GSM modem (dual/tri-band version available) through a GPRS network or, if not available, by means of a GSM network. In areas with no GPRS/GSM coverage, position-data and events are stored in memory. As soon as communication is restored, all information is transmitted.
A unique feature is the user-configuration menu, which controls events like sending position-information and switching of external hardware. Changing this configuration is possible remotely or on-site. Virtually every parameter can be controlled, to adjust the TraceME/TrackME Module exactly to your needs!

## Applications

- Fleet management
- Public transport
- Railway industry
- Logistics
- M2M
- Security and surveillance
- Remote control and diagnostics
- Vehicle immobilisation

## Evaluation Kit/Support

- KCS TraceME evalution kit
  Order code EVAL01

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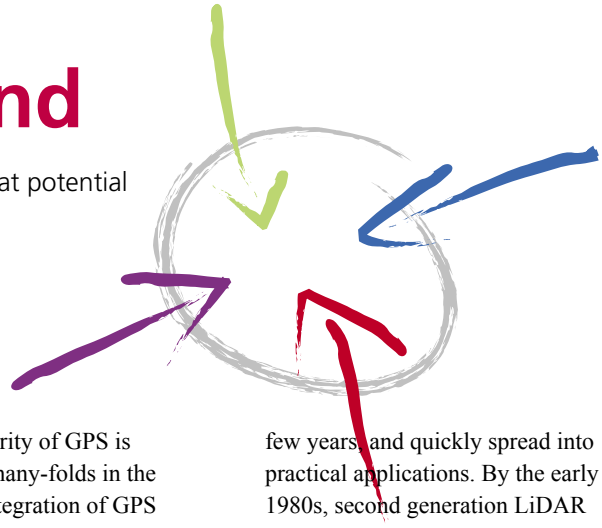
# Going hand in hand

The combination of aerial photography and LiDAR has great potential

**Madhav N Kulkarni and D M Satale**



With the launch of GPS in the 1980s, the task of providing control points for mapping purposes was greatly simplified, leading to economy and ease of operation. The technique of LASER mapping, which existed decades before GPS, also received a boost due to GPS, as instantaneous precise positioning of the exposure station during the mobile LASER mapping operation was made possible by GPS, thus solving a major problem in LASER mapping. The recent GPS modernization programme, and the introduction of GNSS, an extension of GPS by addition of two more satellite systems, has further enhanced the utility of satellite positioning for mapping applications.

## GPS modernization and GNSS

GPS is the first surveying technique to offer applications in a very wide range of spheres, from mm-level high-precision geodesy to the few m-level real-time positioning, at an unprecedented speed and low cost. Continuing research efforts to improve the field data collection, orbit prediction, hardware and software developments and modelling and data processing have contributed towards making GPS the most widely used system of this century. The International GPS for Geodynamics Service (IGS) has proved the suitability of GPS for high-precision scientific tasks such as monitoring the crustal motions, the Earth rotation, etc. With the recently launched GPS modernization programme, to introduce a "civilian" code on L2 frequency, called L2C, and a third "civilian" frequency, called L5, the precision and integrity of GPS is likely to increase many-folds in the near future. The integration of GPS with the Russian System- GLONASS, and the new European system being launched: the GALILEO, the concept of integrated satellite-bases positioning and navigation through GNSS will soon become a reality. The GPS - International Navigation System (INS) integration, kinematic GPS survey techniques, psuedolites as substitute for GPS in the event of outages, the launching of Wide Area Augmentation Systems (WAAS) for civil aviation, etc. are some of the promising developments in this field, which will make the system most versatile and trust-worthy in the near future.

## LiDAR

The Light Detection And Ranging (LiDAR) is a relatively new technological tool, which is very useful for terrain mapping, and hence, widely accepted around the world. This technology is also known as Airborne Laser Terrain Mapping (ALTM), Airborne Swath Mapping (ASM), Airborne Laser Mapping (ALM) or Airborne Laser Scanning (ALS).

LiDAR is much faster than conventional photogrammetric technology and the data is easily combined with other type of data, through many commercial software products, for numerous applications. Its development goes back to 1970s and 1980s, with the introduction of the early NASA-LiDAR systems, and other attempts in USA and Canada (Ackermann, 1999). The method has successfully established itself as an important technique, within a few years and quickly spread into practical applications. By the early 1980s, second generation LiDAR systems were in use around the world. These were expensive and had limited capability, and were generally used only by federal agencies in USA. With the enhanced computer power currently available, and with the latest positioning and orientation systems, including GNSS, LiDAR systems have become a commercially viable alternative for development of Digital Elevation Models (DEMs) of earth surface.

LiDAR can be useful for collection of elevation data in case of dense forests, where photogrammetry fails to reveal the accurate terrain information, due to dense canopy cover. Not limited by the environmental conditions restricting aerial photography, airborne laser scanning technology is emerging as an attractive alternative to the traditional technology for large-scale geospatial data capture.

## LiDAR data collection

A pulsed laser ranging system is mounted in an aircraft equipped with a precise kinematic GPS receiver and an Inertial Navigation System (INS). By accurately timing the round trip travel time of the light pulses from the aircraft to the ground (water, foliage, buildings or other surface features), it is possible to determine the range with a precision of one centimeter or better. Solid-state lasers are now available that can produce thousands of pulses per second, each pulse having a duration of a few nanoseconds (10-9 seconds). Using a rotating mirror inside the laser transmitter, the laser

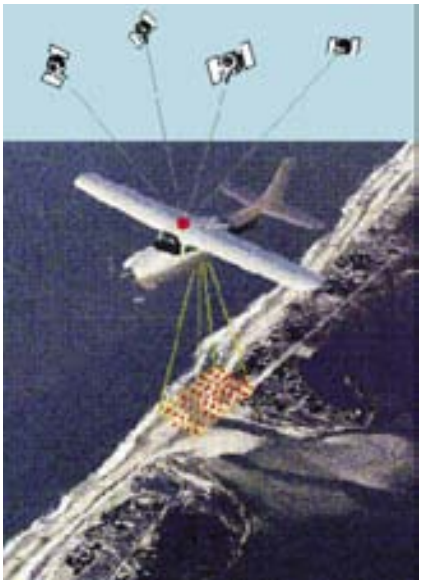


**Fig. 1: LiDAR Concept**

pulses can be made to sweep through an angle, tracing out a line on the ground. By reversing the direction of rotation at a selected angular interval, the laser pulses can be made to scan back and forth along a line. When such a laser ranging system is mounted in an aircraft with the scan line perpendicular to the direction of flight, it produces a saw tooth pattern along the flight path as shown in figure 2.

The width of the strip or "swath" covered by the ranges, and the spacing between measurement points, depends on the scan angle of the laser ranging system and the airplane height. Using a light twin or single engine aircraft, typical operating parameters are: flying speeds of 200 to 250 kilometers per hour (55 to 70 meters per second), flying heights of 300 to 1000 meters, scan angles generally ±30, to ±20 degrees, and pulse rates of 2000 to 50000 pulses per second.

These parameters can be selected to yield a measurement point every few meters, with a footprint of 10 to 15 centimeters, providing enough information to create a Digital Terrain Model (DTM) adequate for most applications, including the mapping of storm damage to beaches, in a single pass. The primary factor in the final DTM accuracy is the airborne GPS data. Errors in the location and orientation of the aircraft, the beam director angle, atmospheric refraction model and several other sources degrade the co-ordinates of the surface point to 5 to 10 centimeters (Shrestha and Canter, 1998).

After a flight, the precise position of the aircraft at the exact epoch of each range measurement is computed relative to nearby GPS ground stations using phase differenced kinematic Global Positioning System (DGPS) techniques. The laser ranging vectors are added to the aircraft positions to derive three dimensional X,Y,Z coordinates of each ground point.

Because airborne GPS data is critical to overall accuracy, flight layouts should optimize the GPS component. To ensure desired accuracies, the use of six satellites at all times during the data-collection is preferred, although solutions can be delivered with a minimum of four satellites. Further, ground-reference receivers should be located every 15 kilometers to 20 kilometers.

## Comparison with other techniques

LiDAR is an emerging technique for data collection and is found to be very accurate and suitable, as compared to the currently available techniques, like photogrammetry and RADAR. Until recently, only conventional techniques of topographic data collection (viz. Surveying, levelling, photogrammetry, satellite stereogrammetry etc.) were available to the geomatics community. These techniques suffer from one or other

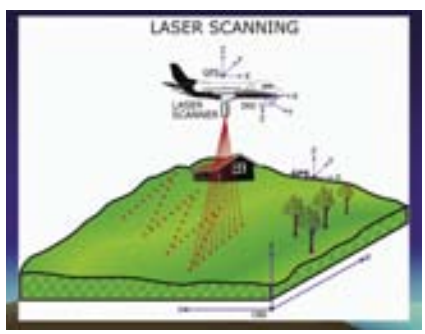



**Fig. 2: LASER Scanning**

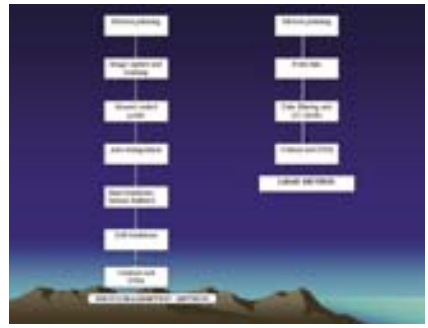


**Fig. 3: LiDAR Data Processing**

limitation in terms of their accuracy, resolution, time, site inaccessibility, weather and sunlight dependence, etc. LiDAR, however, promises to eliminate most of the handicaps of conventional methods, and is establishing itself as a major player in the topographic, data collection industry. LiDAR is an active illumination sensor; a laser system can collect data at night and can be operated in the any weather and at low sun angles, that prohibit aerial photography.

With LiDAR, DTM can be generated more rapidly and accurately than with photogrammetry, due to digital acquisition of the data and the direct range measurement. Calculations show that LiDAR requires only 25% to 33% of the budget as compared to photogrammetric compilation (Petzold et al., 1999).

Interferometric Synthetic Aperture Radar (InSAR) is a new and rapidly evolving technique useful for DEM generation, which seems to be competitor of LiDAR in resent years. But the accuracies achieved so far by InSAR are usually in the range of 1 meter, on the contrary, LiDAR gives vertical accuracies in the range of 10 to 15 centimeters, which is well tested by conducting number of pilot projects in various countries around the world.

Layovers is a major problem in INSAR, creating lots of problems in generating accurate DTM, especially in the hilly terrain with wide variation in topography, and in urban areas with skyscrapers, which introduce significant errors. On the contrary, LiDAR is not affected by layovers and shows promising results.

## DTM generation from LiDAR

LiDAR data is useful for generating Digital Elevation Model (DEM) and relief maps. DEM gives the height information and three-dimensional view of the topography. This information is very much useful in various engineering and military application. The X,Y,Z coordinates of the ground points can be processed using a number of commercially available software packages to produce a DEM, and many other products such as shaded relief maps, contour maps, cross sections and surface profiles.The ASCII data collected by LiDAR can be imported into software like Arc-view, Microstation, etc., to represent into point format. After initial editing, the contours can be generated by using software like Terramodel, GRAM++ and Arcinfo. After interpolating contour data into the software, Digital Surface Model (DSM) and shaded relief map can be generated from this data (see figure 4). The shaded relief map of the area shown in figure 5 is generated by using GRAM++ GIS package, developed by Centre of Studies in Resource Engineering (CSRE), IIT Bombay.

## Applications

LiDAR has numerous applications in various engineering fields; some of which are quite unique. Some of the important LiDAR applications are described here.

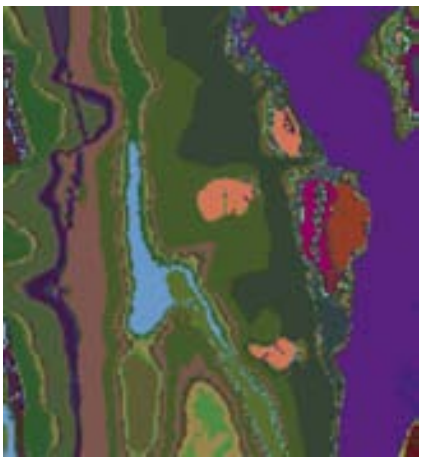


**Fig 4. DSM generated from LiDAR data**

### Beach Mapping

Highly accurate, dense and rapidly obtained data sets are most suitable for coastal applications like sediment transport, coastal erosion and coastal flood models. This new capability opens for the first time the possibility to regularly monitor the beaches, to map just prior to and immediately after major storms, to obtain accurate quantitative information about the extent of the damage (Shrestha and Canter, 1998).

### Forest studies

Laser-based LiDAR systems offer distinct advantages over existing survey instruments in areas such as forest surveys. A unique advantage of these instruments is that they are capable of penetrating vegetation, allowing the ground beneath a tree canopy to be mapped directly from the air.

### Infrastructure construction, maintenance, and management

LiDAR can also be effectively employed for corridor mapping to plan oil and gas pipelines, and for their post -commission maintenance. The tasks from the field survey to the final data delivery can be accomplished within weeks, which otherwise, using the conventional methods, would take months. LiDAR is useful in generating DTM for road planning and design (Janssen and Gomes, 1999).

### Transmission Lines Mapping

Long stretches of transmission lines can be mapped with great speed, to determine the exact location of the transmission towers, accurate topography of the corridor, and the encroachment by vegetation for modification and repair purposes (Lohani, 2000).

### Architecture and landscape design/ Three- dimensional modeling

Automatic integration of an architectural design with its surrounding, represented by a high-resolution 3D landscape model obtained by LiDAR, that includes existing vegetation, facilitates the design process and gives an accurate impression of how your design interacts with its surrounding.

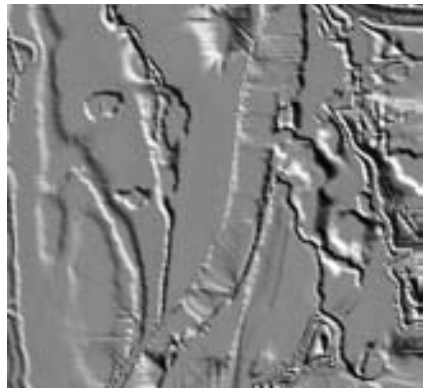


**Fig 5. Relief map from LiDAR data**

### Disaster prevention and response

LiDAR is very helpful to determine areas prone to natural hazards like floods, and to rapidly assess the damage to infrastructure after natural disasters like earthquakes, storms, and landslides on a larger scale.

### Other applications of LiDAR

- Landslide Mapping
- Volcano monitoring
- Bathymetry
- Urban planning and development
- Ecology and environment

## Integration of photogrammetry and LiDAR

The combination of aerial photography and LiDAR has great potential. Results and performance could certainly be enhanced, if laser scanning system is supplemented by taking aerial photographs. One can imagine the benefits of high-resolution imagery and a dense LiDAR-generated DEM. The LiDAR DEM tends to be much denser that those available through current sources. This potentially leads to more accurate orthorectification. The user enjoys the benefits of high spatial resolution from the imagery and a very accurate, dense DEM from the LiDAR system. For more details, see (Satale, 2003).

## International and Indian scenario

LiDAR is commercially operational in various countries like USA, Canada and in Europe. A few LiDAR projects have been taken up in India recently, mostly on pilot basis.

In India, there are many of ongoing and proposed projects related to roadways, railways, oil and gas pipelines, electric transmission lines, communication network, ports and harbors, for which speedy collection of accurate topographic data is an important factor, which reduces the cost of the entire project dramatically. Delays in project work due to the limitations of conventional data collection approaches may also be minimized, by using technologies like LiDAR. India is prone to natural disasters of varied forms, resulting in heavy losses of life and wealth. LiDAR data have the potential to be effective in many disaster management programs, including the frequently occurring floods, like the Mumbai floods of July, 2005. The LiDAR technology can be very effectively used for such important applications.

## Conclusions

The main advantages of LiDAR are accuracy of measurements, high automation and fast delivery times. Due to its typical characteristics, both in data collection and data type, LiDAR has opened up several new applications, which were not economically feasible with the conventional techniques. In India the technology is yet to make its impact on the mapping, and has still a long way to go. Looking at the potentials of this technology, it is obvious that LiDAR will play a major role in geospatial applications in near future.

## Acknowledgements

The research work related to comparison of photogrammetry and LiDAR was carried out by the second author, under the guidance of the first author, as part of M.Tech. thesis.

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**Madhav N Kulkarni**
Department Of Civil Engineering, Indian Institute of Technology, Bombay
**kulkarni@iitb.ac.in**

**D M Satale**
Department Of Civil Engineering, Indian Institute of Technology, Bombay, India

# George Everest: Early years in India

Calcutta Headquarter of the Survey of India

George Everest entered the Bengal Artillery as a Lieutenant on 4 April 1806 before he had even reached his 16th birthday. This rapid promotion was due to the number of vacancies at that time. Little has come to light about the first few years of his service in India until the siege of Kalinjar near Allahabad in 1812.

The first corroborated appearance of Everest involved in survey work is in 1813 when he was in Java although one reference suggests that he may have been there as early as 1807. Java at that time under Dutch control was of prime importance to the East India Company which had various settlements there but the capital, Batavia was overrun by the French in 1811. As a result the Governor General of India sent a force to recapture the city which they achieved on 26 August 1811. It was held until 1816 when it was restored to the Dutch. In the intervening 5 years the East India Company took the opportunity to make detailed surveys of important parts of the island.


Extract from map indicating cooperation between Lambtom and Everest

A reconnaissance was started in 1812 but in 1815 Lt Everest was appointed to complete the survey. Maybe it was because of his known interests in mathematics and astronomy that Everest was given this task as there is no mention of any survey practice for him before then except that which he would have done whilst at the Woolwich Academy. In fact young Everest was very keen to learn and it is said that one of his first acts after reaching India was to seek out appropriate teachers of the local languages so that he might be achieve reasonable fluency. After this he sought fresh subjects to study and found some mathematical and astronomical textbooks and became self-taught to a very high standard in these subjects. This ability was to be of considerable use throughout his life.

For any survey work he did he was obliged to purchase his own equipment so he had but a simple form of theodolite to use. As might be expected, the areas of particular interest were the strategic ones of mountains, harbours, communication routes and near-shore waters. Everest arrived back in Calcutta on 20 November 1916.

A few months later his skills were sought in relation to the introduction of a visual telegraphic system stretching west from Calcutta. He had hardly got half way on this scheme that was to cover 400 miles when he heard of his appointment as Chief Assistant to Col. William Lambton on the Great Trigonometrical Survey. On completing the telegraph line he marched from its terminal at Chunar to Hyderabad surveying the route as he went.

Everest joined Lambton on 8 January 1819 and the two of them observed some of the Arc stations near Bidar. An indication of Everest's ability is given by the fact that within three weeks he was in full control of the sections he was observing. Unfortunately his initiation into the GTS was in one of the worst parts of the country as far as health, vegetation, and climate was concerned He had one problem after another and he described many of these eloquently and at some length in various of his Reports. But conditions only worsened and by October 1819 he was seized by fever and in just five days 150 of his followers were similarly struck down. While making their way back to Hyderabad 15 of the followers were to die. Although Everest tried to continue the next year within weeks he was a gain struck down and on 1st October 1820 sailed to the Cape of Good Hope to recuperate.

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# India's phone coordinates

Easy 2-Steps to a "Smooth and Convenient" Future!

**Muneendra Kumar, PHD, munismk@yahoo.com**

In India, the "extra" digits in telephone numbers have been added a number of times e.g., the digits for Delhi have changed from 5 to 8 in the past five decades. However, with the addition of extra digit of "2" (or "3" or "5") in the phone numbers of the cities around the countries in December 2002, the total number has reached to "10", i.e., "2, 3, or 4" digits of city codes plus "8, 7, or 6" digits of phone numbers. In one colony of Delhi, since December 2002, the phone numbers have changed from 2527-1234 to 3097-1234 and then to 3297-1234, i.e., three times in three years.

## Forthcoming future

In a few countries in Western Europe, 9-digit phone numbers have already started popping out. In case of India with one billion plus population and booming popularity of mobile phones, addition of an "extra" digit in phone numbers is a distinct possibility. Furthermore, India might need a new series of "village" codes, as phones would become popular with villagers.

## Opportunity waiting

The "10-digit" phone numbers now provide an opportunity that India's phone numbering system can be redesigned into a new format of "3" digit area codes, as a replacement of present city codes, plus the "7" digit phone numbers to replace the variable digits. This will also eliminate the need for adding of extra digits into phone numbers in the future.

## Future adding of phones

As the new phone numbers grow in any state, city, or "area", a new "3" digit area code can be added with a set of 10 million "7" digit phone numbers.

## Easy updating

First Step -

The present practice of dialing 10-digits for mobile phones or city codes and phone numbers for Delhi and its neighboring cities should be extended to all "other" areas and phones. Thus, this would require that the "city" codes are to be included in all phone calls for all over India.

Second Step -

Once the 10-digit dialing (Step 1) becomes an All India feature, then the "city code plus phone number" is to be reformatted to "area code plus phone number" as per the scheme detailed below.

## Suggested "Reformatted" scheme

The complete reformatted numbering scheme will evolve as under:

Area Codes:

| a. For Existing Numbering From | | Proposed Numbering To |
|---|---|---|
| 11-2nnn-mmmm | - | 112-nnn-mmmm (Delhi) |
| 11-3nnn-mmmm | - | 113-nnn-mmmm (Delhi) |
| 22-2nnn-mmmm | - | 222-nnn-mmmm (Mumbai) |
| 22-5nnn-mmmm | - | 225-nnn-mmmm (Mumbai) |
| 124-nnn-mmmm | - | 124-nnn-mmmm (Gurgaon) |
| 1262-nnn-mmm | | 126-2nn-nmmm (Rohtak) |

b. Adding New Numbers in the Future:
As the need to add new numbers arises in the future, a NEW area code can be added:
114-nnn-mmmm; 115-nnn-mmmm; so on for Delhi.
223-nnn-mmmm; 224-nnn-mmmm; 226-nnn-mmmm; so on for Mumbai.

This system will have provision for addition of 10 million numbers under any one new area code. It will not "overflow" in the next 50 years or so.

Caution: The addition of numbers for ALL new phones, due to (1) introduction of a new phone company or type and (2) new phone line, must be an integral part of the unified national numbering scheme.

Calling within and between area codes -

a) Within the same area code - No need to dial the preceding "0".
b) Toll calling between any two area codes -
A caller will be required to dial "0" before dialing the "10" digit number (3-digit area code + 7-digit phone number) of the "OTHER" area. ALL calls with preceding "0" will be subjected to TOLL charges.
c) Free calling between two "neighboring" area codes
In cases like NOIDA and Delhi, where the calls are considered local with no charges, callers will not need to add a "0". If a "0" is added (when caller may not be certain whether the call is local), the computer will IGNORE the zero.

NOTE: This procedure will standardize the toll-free calling between neighboring area codes.

Cell phone numbering
Once the new scheme is accepted,

it will also be the right timing to regulate the growth in mobile phone numbers in a "designed" area code type format.

a) Grouping in area codes
States (in varying numbers) could be grouped into "area" code format for future expansion. The present "open" numbers starting with "98" should be regulated immediately.

b Future extensions
As an example, Delhi area codes can be as 971, 961, 951, and so on. Once the series starting with "9" overflows, a new series could be designed with "8".

c) Toll calls
To start a "toll" call, e.g., between two area codes of mobile phones, caller will be using "0".

## Special area codes

a) Toll free
Area codes like "600, 700, and 800" should be reserved to start with. Also, area codes like 666, 777, 888 can also be reserved for future expansion. Toll free calls to these numbers should not be allowed from outside the country to any caller.

b) Toll Code(s)
To start, code 900 can be designated where the caller pays to obtain a special service or information from a commercial firm or agency. In all such a case, the commercial firm or agency must advertise and/or inform the caller right at the start of the call about the charge(s) per minute to protect the users of malpractice.

c) Government codes
Central Government – 100
State Governments - 101, 102, 103, and so on.

d) Tourism codes
Codes "555" and "999" could be reserved for tourism.

## Special numbering

a) Emergency from Anywhere - "911" (w/o Area Code)
Medical Hflp (Local) - "811"
Traffic Help (Local) - "711"
Police (Local) - "611"

b) Phone Enquiry (Local) - "511"

c) Alphabet s - "2 for a, b, c", "3 for c, d, e", "4 for f, g, h", "5 for I, j, k", "6 for m, n, o", "7 for p, q, r, s", "8 for t, u, v", and "9 for w, x, y, z".

## Examples

| | |
|---|---|
| Emergency (From Anywhere) | - 911 |
| Holiday Inn in Mumbai | -222-HOLIDAY |
| Marriott in Delhi | - 112 MARRIOTT (Last digit is ignored) |
| Air India in Delhi | -112-AIR- INDIA (Last digit is ignored) |
| Central Health Ministry | 100-4-HEALTH |
| State Tourism Office | 101-TOURISM |
| Phone Enquiry in Delhi (From other area codes) | - 112-511 |

## Summary

A unified and integrated national telephone numbering scheme will ensure in easy 2-steps "Good Phone Coordinates" for a smooth and convenient future!

# Celebrating national survey day

The Geodetic of Research Branch, Survey of India joined hands with Institution of Surveyors Dehra Dun Branch in organizing a workshop on Role of Geodesy in Surveying Practices, 10-11 April, 2006, Dehradun, India. There would be no better celebration for National Survey Day. The occasion was also used to pay tribute to Pt Nain Singh one of the greatest explores of 19th Century

The inauguration function was graced by Lt. Gen. (Retired) TPS Rawat, Honorable Minister for Tourism, Govt of Uttaranchal; Dr RS Tolia, Chief Information Commissioner, Uttaranchal; Brig PN Koul; Brig (Dr.) B Nagarajan, Chairman, Institution of Surveyor, Dehradun Branch and Shri G Varun Kumar, Secretary Institution of Surveyor, Dehradun Branch. Brig (Dr) B Nagarajan threw light on the past achievements of Geodetic and Research Branch and prospective role and developmental plan to meet the current users requirement. Dr RS Tolia talked about how Pt Nain Singh suffered hardship in his early stage of life and reached to become one of the most adorable name in Indian Survey history. Lt Gen (Retired) TPS Rawat in his chief guest address told the audience about the steps taken by the Uttaranchal Goverbment to enhance the facilities for tourists at various level. Brig Koul talked about the various activities undertaken by Institutions of Surveyors and steps taken to resolve the issues of map and other Geospatial data availability in public domain. In all nearly 30 technical papers were presented. A no. of technology demonstration by vendors from M/s Trimble Navigation, CITES, PAN INDIA Shotam instruments, AIMIL Ltd. and M/s ERDAS India were also held. In valedictory session Dr Bhoop Singh spoke about the activities sponsored by Department of Science and technology. Professor Anbalgan talked about the research projects undertaken by Earth Science Department of IIT Roorkee. Dr Govil of Indian Institute of Remote Sensing also addressed the gathering.

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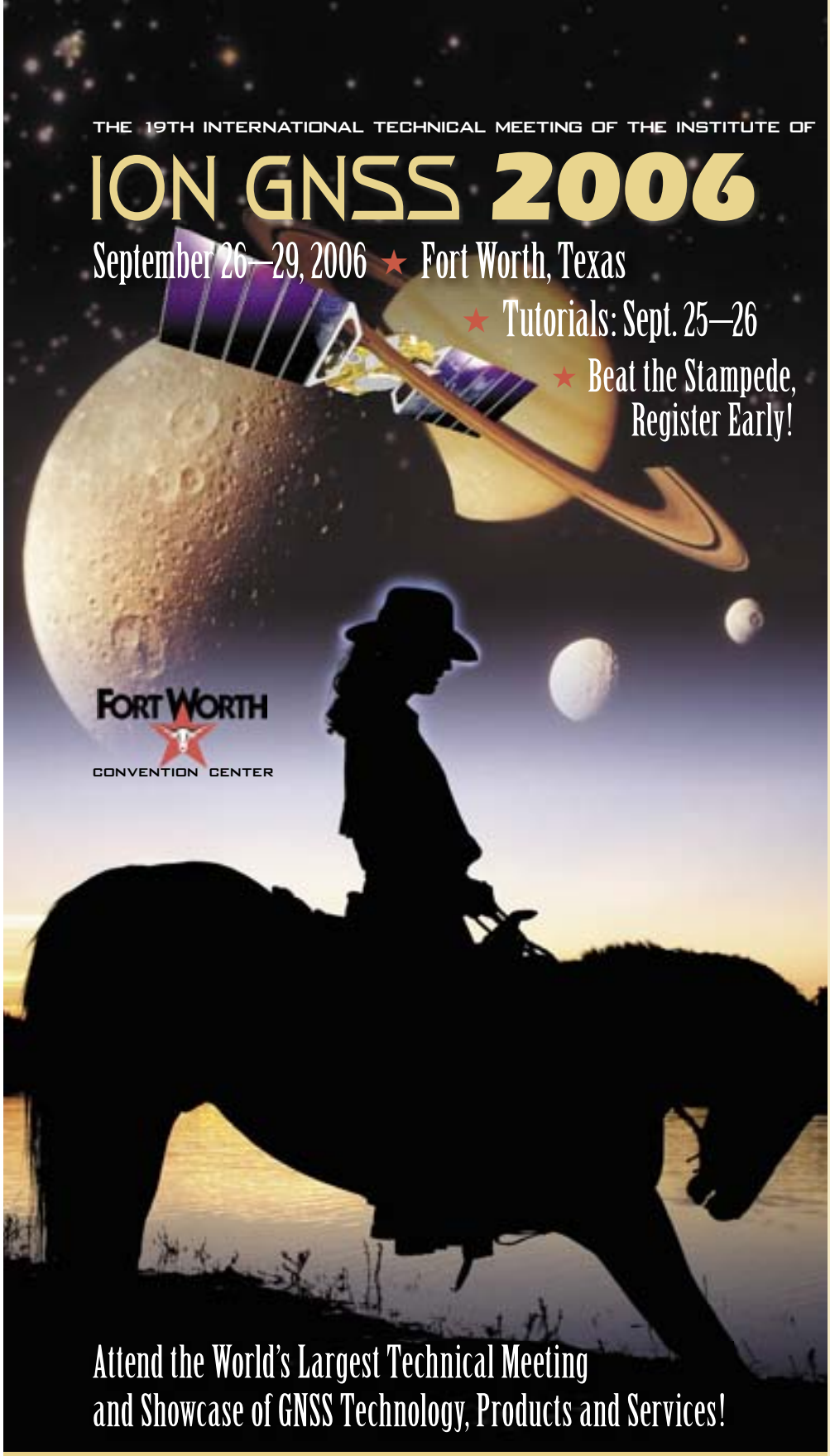


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**Leica Geosystems**
Woodlands East Industrial Estate
Singapore 738068
Telephone: +65 6511 6581
Email: juliana.tay@leica-geosystems.com
**www.leica-geosystems.com**

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