RNI: DELENG/2005/15153
Publication: 15th of every month
Posting: 19th/20th of every month at NDPSO

No: DL(E)-01/5079/05-07
Licensed to post without pre-payment U(E) 28/2006-07
Rs.100

ISSN 0973-2136

Coordinates

Volume III, Issue 1, January 2007

A MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

A cGIT publication

RTK STAR S82

Specification

Channel: Independent 24C
Tracking Signal: L1/L2
Static Horizontal Accuracy: 5mm+1ppm
Static Vertical Accuracy: 10mm+2ppm
Static Operation Range: <=80km
Static Memory: 32M Built-in
RTK Horizontal Accuracy: 2cm+1ppm
RTK Vertical Accuracy: 3cm+1ppm
RTK operation range : <=8km
Communication Mode: USB / Bluetooth / Serial Port
Data link: 25W/15W, 5W/2W and 2W/0.5W selectable
RTK Initialization Time: Typically 15 Seconds

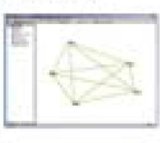
Data Collector

NEW DATA LINK,BATTERY,MORE CONVENIENT

STATIC GPS 9600

- L1, C/A Code
- 12 Channels
- Horizontal Accuracy: 5mm+1ppm
- Vertical Accuracy: 10mm+2ppm

Post-processing Software



DIFFERENTIAL GPS 9200

Besides static receiver, 9600 can be updated to differential surveying system. 1-2 bases or rovers can work independently.

Specification

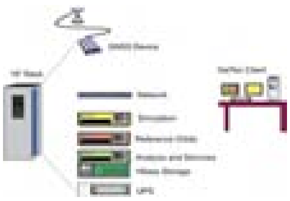
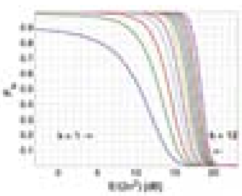
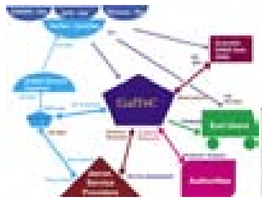
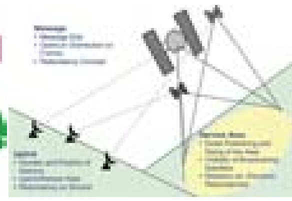
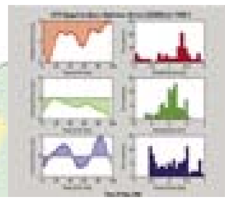
- L1, C/A Code
- Single Positioning: 5-10m
- 16M Memory Built-in
- Horizontal Accuracy: 1m
- Static Accuracy: 5mm+1ppm

SOUTH SOUTH SURVEYING & MAPPING INSTRUMENT CO., LTD.
Add: 4/F, No. 8, Jian Gong Road, Tian He Software Park, Zhong Shan Avenue West, Guangzhou 510665, China
Tel: +86-20-85529099 / 85524990 Fax: +86-20-85524889 / 85529089
Email: export@southsurvey.com / mail@southsurvey.com
Website: www.southsurvey.com/english/index.asp

CONTENTS – VOLUME 3, ISSUE 1, JANUARY 2007

Articles

Positioning and navigating: 2007 Akio Yasuda, Dick Smith, Gerard Lachapelle, Ian Dowman, John W Lavrakas, Sang Jeong Lee, Vanessa Lawrence 6 Gagan update Arjun Singh, S K Saraswati and K Ramalingam 10 North pole keeps moving south Muneendra Kumar 12 Acquisition sensitivity limits of new civil GNSS signals Seppo Turunen 14 US National Space Policy George Cho 22 Can use of GPS be legal in India? Sudipto Roy 25 Galileo Technology Centre H Su, W Ehret, H Blomenhofer, E Blomenhofer 26

Columns

My coordinates editorial 4 News galileo update 11 industry 34 remote sensing 35 lbs 36 gis 37 gps 37 Mark your calendar January to november 38

cGIT 28A Pocket D, SFS Mayur Vihar Phase III, Delhi 110 096, India. Phones +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

This issue has been made possible by the support and good wishes of the following individuals and companies Akio Yasuda, Arjun Singh, Dick Smith, E Blomenhofer, George Cho, Gerard Lachapelle, H Blomenhofer, H Su, Ian Dowman, John W Lavrakas, K Ramalingam, Muneendra Kumar, S K Saraswati, Sang Jeong Lee, Seppo Turunen, Sudipto Roy, Vanessa Lawrence, W Ehret and; Contex, HP, Kolida, Leica, Magellan, NRSA, South, Topcon, TraceMe, Trimble; and many others.

Coordinates is an initiative of cGIT that aims to broaden the scope of positioning, navigation and related technologies. cGIT does not neccesarily subscribe to the views expressed by the authors in this magazine and may not be held liable for any losses caused directly or indirectly due to the information provided herein. © cGIT, 2005. Reprinting with permission is encouraged; contact the editor for details. Annual subscription (12 issues) [India] Rs.1,200 [Overseas] US$80

Printed and published by Sanjay Malaviya on behalf of Centre for Geoinformation Technologies (cGIT) at A221 Mangal Apartments, Vasundhara Enclave, Delhi 110096, India.
Editor Bal Krishna | **Owner** Centre for Geoinformation Technologies | **Designer** TSA Effects, www.tsa.in | **Printer** Sonu Printer, A110 DDA Sheds, Okhla, New Delhi, India.

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

On a high…

On Jan 10, India leaped high in space with the successful launch of its tenth Polar Satellite Launch Vehicle (PSLV-C7) that put four satellites into orbit.

India's CARTOSAT-2 and Space capsule Recovery Experiment (SRE-1), Indonesia's LAPAN-TUBSAT and Argentina's PEHUENSAT-1.

Great moments of great achievements.

Time for celebration.

The success of SRE-1 will place India among the group of countries that boast of satellite re-entry technology.

Another reason for celebration.

Cartosat-2, the twelfth in the Indian Remote Sensing (IRS) satellite series, is capable of providing imageries with a spatial resolution better than 1 meter and a swath of 9.6km

As celebrations are on, it is also expected that there will smooth and hassle-free mechanism to access the imageries of Cartosat –2 for genuine users and genuine purposes.

Bal Krishna, Editor
bal@mycoordinates.org

Chief advisor Muneendra Kumar PhD, Chief Geodesist (Retired), US National Geospatial Intelligence Agency, USA **Advisors** Naser El-Sheimy PEng, CRC Professor, Department of Geomatics Engineering, The University of Calgary Canada, George Cho Associate Professor in GIS and the Law, University of Canberra, Australia, Prof Madhav N Kulkarni Department of Civil Engineering, Indian Institute of Technology Bombay, India Dr Abbas Rajabifard Director, Centre for SDI and Land Administration, University of Melbourne, Australia, Luiz Paulo Souto Fortes PhD Associate Director of Geosciences, Brazilian Institute of Geography and Statistics - IBGE, Brazil, John Hannah Professor, School of Surveying, University of Otago, New Zealand

The leading supplier for archiving:

- Fast and reliable solutions
- Accurate scans in superior CCD quality
- Flexible connectivity options
- Easy to use and maintain

Who will you trust your archive to?

Document archives are delicate and sensitive. Maps, drawings and large format originals can be fragile. Information and details easily get lost. Think about this, before you select a scanner for digitalizing it. Ask others in your situation which brand of scanners they rely on. The name Contex is most likely to come to mind. After all, Contex scans more archives with greater accuracy, quality and speed than any other scanners in the world. All Contex scanners are ENERGY STAR® and RoHS Compliant - key features that help protect the environment.

For more details visit us at www.contex.com

contex
WHEN IMAGING MATTERS

Please contact your local distributor:

Australia
Aarqueanitech Pty. Ltd.
www.aarqueanitech.com.au

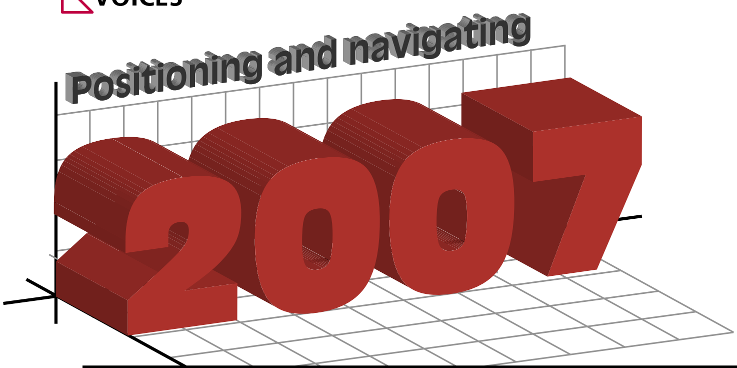
India
CADD Centre
www.caddcentre.co.in

Singapore
Brighter Image Ptd Ltd
www.biscan.com

Thailand
Bangkok Business Equipment
www.bbe-group.com

Vietnam
Harmony Co. Ltd
www.harmony.com.vn

Malaysia
Jardine OneSolution
www.jos.com.my



A cross section of views by leading experts on the possibilities and priorities in Geomatics and GNSS in the year ahead

The cell phone GPS market is growing huge

Akio Yasuda
Professor
Laboratory of Communication Engineering, Tokyo University of Marine Science and Technology, Tokyo, Japan

QZSS is a Japanese Satellite System to augment the performance of GPS positioning. It was expected to provide the services of positioning, communication, and broadcasting.

The schedule of the development delays for waiting the decision of the private sector to invest the new data service. But they gave up the communication and broadcasting services which are originally planned to be installed to QZSS early last year. The first satellite shall be launched in the summer of 2009 being prepared by JAXA (Japan Aerospace Exploration Agency). And after proving the effectiveness by the first satellite, the following satellites will be launched and the full system will be furnished: i.e. the users will be able to receive the signals from the zenith continuously for 24 hours.

It will transmit the L1-SAIF (L1-Submeter-class Augmentation with Integrity Function), which provide the correction data at 250 sps of code ranging to obtain sub-meter positioning accuracy besides the supplement of the modernized GPS signals.

It will also provide the data through the LEX (experimental signal with higher data rate of 2kbps of message), compatibility with Galileo E6 signal at 1279 MHz. This channel will be devoted to the transmission of the carrier measurements data for RTK-GPS positioning.

The format of the L1-SAIF is followed by SBAS data, but the data is designed specifically for Japanese area. It has been tested experimentally and proved to the performance of sub-meter accuracy. The test will be continued to complete the total system, including the user segment, until the end of 2008. The LEX will convey the data for the network-based RTK-GPS usable all over the Japanese Islands. The details, including the format, are under examination. The applications of the GPS positioning using QZS to the various fields are now under development.

As for the user segment, it will be requested from this April to add the positional data in sending the emergency messages by cell phones (so called Japanese version of E-911).

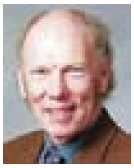
It means that all the cell phones must have the positioning function. The environment of the GPS reception in the urban area is usually poor and signals are weak with sever multipath. The high sensitive GPS receivers with low cost are installed for the first generation of cell phone with GPS. The sever multipath must be reduced to get very accurate positioning. The improvement of GPS itself is continuing. The cell phone GPS market is growing huge, as more than 10 million cell phones will be replaced by newer versions every year. The desire for highly accurate positioning with lower cost never stays. The higher the accuracy, the wider the application fields. The carrier phase positioning with cm level accuracy including new GNSS, such as Galileo and QZSS, is being examined for higher performance.

Competition and harmonization is expected in GNSS

Prof Sang Jeong Lee
Chungnam National University, Korea

With the successful take-off of Galileo and renewed GLONASS, competition and harmonization is expected in GNSS. Since most countries rely on external systems for PNT services, they are likely to want to involve in the operation of GNSS through international cooperation as national PNT infrastructure dependence grows rapidly. Korea also will want to find ways for international cooperation with GPS, Galileo and QZSS. With modernized GPS signals, renewed GLONASS and the Galileo ICD, the convergence trend in IT-related market will be accelerated through added-value by GNSS especially in wireless and location-based service market. In this kind of digital convergence market, safety and security are the most important impact factor. In this regard, technology challenges can be found in interference mitigation, integrity monitoring, and anti-spoofing for civil applications.

Geomatics education needs attention



Ian Dowman
President,
International Society for Photogrammetry and Remote Sensing (ISPRS)

If there is one aspect of Geomatics which needs attention in 2007 it is education; or more specifically funding for education. Education is needed at many levels: basic training of technicians: education and training of specialists, development of management skills, and education of decision makers. Geomatics offers tools which can work towards solutions of many of the problems facing society today, but there are not enough educated geomatics professionals in the right places to show decision makers that this is the case. There are many excellent institutions in the developed and developing world which are training and educating people in the skills of acquiring, analyzing, and managing geospatial data, but in many cases these organisations are threatened by closure or amalgamation because of too few students. Why is this? Often because there are insufficient funds to allow qualified students to attend the courses, or because potential students are not aware of the possibilities of studying Geomatics and how the skills involved can tackle the problems which global society faces. There is a strong emphasis in the world today on concentrating efforts on serving society. In developed countries, the focus is in areas where the proper management of geospatial data and information can help, such as improving security, transport, and healthcare whereas in developing countries, the Millennium Development Goals encapsulate these aspirations. In either case, specialists educated in the techniques and practice of Geomatics and decision makers are informed in the enormous value of geospatial data can direct efforts towards using the information to help in improving society.

Expansion of education and collaboration between organisations is the key to better use of geospatial data to serve society.

More cooperation between providers

Dick Smith
President
International Association of Institutes of Navigation

The inexorable advance of technology will continue to the benefit of GNSS and its applications. There will be more co-operation between providers to the benefit of users worldwide. This will be evident in the work of new International Committee on Global Navigation Satellite Systems (ICG). Established last year, the ICG starts its programme of work in 2007. There will be no fanfares from this United Nations body but instead steady, quiet progress to promote the global use and application of GNSS. The committee aims to encourage co-ordination among providers, ensuring greater compatibility and interoperability, and to promote the introduction of GNSS, particularly in developing countries. An ambitious work plan has been drawn up including consideration of standards, provision of information and regional reference systems, with currently 5 working groups to lead in each area. The ICG will make decisions through consensus. These decisions will not create legal obligations and will be acted upon at the discretion of each member i.e. the committee is advisory, only providing co-ordinated expert advice. I expect its recommendations will be carefully considered since all the GNSS providers are members.

Emerging wireless applications

Professor Gerard Lachapelle
CRC/iCORE
Chair in Wireless Location, Dept of Geomatics Eng, University of Calgary

Some of the major GNSS developments that will have a major impact on geomatics in the year 2007 will include the following:

The structures of GPS L2C and L5, Galileo and GLONASS signals will continue to yield innovative signal processing methods that will improve measurement performance, both outdoor and indoor.

Commercial GNSS equipment and software that can make and process measurements on GPS L1/L2C and GLONASS will become widely available.

The impact of several additional GPS satellites with L2C capabilities on navigation and positioning performance will start to become significant in view of the addition of a second frequency. As the GLONASS constellation becomes increasingly populated, its impact on availability, accuracy, and reliability will become correspondingly become significant for a number of applications.

Thanks to growing markets and intense competition among manufacturers, improvements of GNSS signal tracking under attenuated conditions such as indoor will improve by several dBs. This enhancement, coupled with increasingly low chipset power requirements and advances in signal processing, will result in new and far reaching wireless applications.

2007

A transitional year towards larger accomplishment

John W Lavrakas
President
Advanced Research Corporation and President, Institue of Navigation for 2007 **John.Lavrakas@advancedresearchcorp.com**

For those of us in the field of satellite navigation, the future looks extremely promising. Why, just in the next five years, we will see the build-out of the Galileo system, the completion of the Russian GLONASS system, the beginnings of GPS dual frequency and triple frequency operation, and the launch of the Chinese Beidou (Compass) system. What of those who cannot wait? What is to be expected this year?

Here is my prediction of what will transpire in 2007. I believe this year will be one of transition, in which we begin the move toward these larger accomplishments expected in the next five to ten years.

- Further announcements on China's Compass system – last November, China announced plans to deploy its own 35-satellite navigation system, but did not supply many details. This year, as questions are put forward, I believe China will provide more detail on their plans, including a more detailed timeline, service description, and discussion on compatibility with other GNSS systems.
- Launch of two or more GPS satellites having the new L2C civil signal – the US Government will have at least two more Block IIRM satellites in orbit, perhaps as many as five additional satellites.
- Launch of second test satellite for Galileo – Galileo has committed to launch its second test satellite this year, which may include additional capabilities not found in its first, GIOVE-A.
- Launch of three (possibly more) GLONASS satellites – GLONASS will continue to add satellites as it moves towards its stated goal of full operational capability with 24 satellites by 2009. The newer satellites have improved performance and a longer design life, resulting in a more stable constellation and improved accuracies.
- Alignment of GLONASS with GPS/Galileo on use of CDMA – GLONASS officials have indicated they are considering a shift from FDMA to CDMA architecture. Perhaps we will hear more about this in 2007.
- Additional international agreements on GNSS (as transpired last year with Galileo and GPS) – I expect we will continue to see more agreements announced as countries sign on to service with Galileo, GPS and GLONASS.

Customer demand to drive geomatics

Vanessa Lawrence
Director General and Chief Executive, Ordnance Survey

Customer demand will still drive geomatics technologies. In Great Britain, we will see this in the continued commercialisation by business partners of Ordnance Survey's national GPS infrastructure and the development of interoperable standards in surveying and recording of underground utility services.

I believe 2007 will see public services and businesses increase their use of national geographic information (GI) in mainstream applications, deriving even greater efficiencies for their users.

For the wider public too, there is growing exposure of the power of easy-to-use GI tools on the internet to help visualise and interpret vital information, such as route finding applications, local council services, and environmental data. Boosted by this, the geomatics industry now has an excellent opportunity to demonstrate that all kinds of decision-making can be truly enhanced through GI.

To derive maximum benefit for everyone, we as the industry, must collectively champion and promote a coherent, systematic approach to GI management based on ICT best practice. In 2007, the UK Government will be presented with a co-ordinated strategy for GI initially for the public sector but hopefully to be adopted by the private sector as well. If the strategy implementation is funded and successfully implemented, I hope the use of GI will be embedded throughout both the public and private sectors as a normal decision-making tool, allowing GI to lose its 'special and technical' tag as a subject.

Coordinates
is available for free download at

www.mycoordinates.org

Get your copy today!

GET ACCURATE MAPS PRINTED REALLY FAST.

HP printers are #1 in large format printing according to IDC's India Q3 2006 market tracker.

Presenting the HP Designjet 4500 printer series. From intricate maps to complex graphs and designs, this new printer series gives you professional quality prints of up to 2400x1200 dpi[2] with a ± 0.1% line accuracy[3]. Its embedded print & web server and Dual Roll Feed capability enhance your efficiency and print management capabilities, while HP Double Swath Technology helps you print at incredible speeds of up to 93 sqm/hr or A1/D size in 25 seconds[1]. So, get one and add precision to your prints.

HP DESIGNJET 4500 PRINTER

Rs. 5,90,999*

- 25 secs/A1[1], 93 sqm/hr[1] in fast mode
- 4 colour printer with outstanding line accuracy and high image quality (Up to 2400 x 1200 optimised dpi resolution[2] and ±0.1% line accuracy[3])
- 40 GB Hard Disk & 256MB Memory
- 2 automatic rolls & switching
- PS and PDF file formats, thanks to Embedded Web Server
- 1 year on-site warranty

HP DESIGNJET 4500 SCANNER

Rs. 10,79,999*

- Speed colour 7.5 cms/second, BW 25 cms/second
- Up to 2400 X 2400 dpi with variable resolution settings from 50 dpi
- 1 GB memory
- Intel® Pentium® 4 2.8GHz processor
- Scan width 107 cms
- Touch Screen Panel
- 1 year on-site warranty

Also available: HP Designjet 4500mfp (consists of HP Designjet 4500 Printer and Scanner)

For details on end-user offer call the numbers given below.

HP Dial-a-cartridge
3030 4499 OR
1800 425 4999
doorstep delivery

Call **3030 4499 (from mobile) or**
1800 425 4999 (from MTNL/BSNL lines)
Visit **www.designjet.hp.com**
E-mail **dhirendra.khurana@hp.com**

hp invent

*Est. street price, taxes extra. [1]Multi-copy printing. Printed in Fast mode on HP Bright White Inkjet Paper (Bond). Speed indicated is maximum printer speed. [2]From 1200 x 1200 input dpi. [3]±0.1% of the specified vector length or ± 0.1 mm (whichever is greater) at 23°C (73°F), 50-60% relative humidity, on A0 printing material in Best or Normal mode with HP Matte Film. For details, please contact your nearest HP Designjet Partner. ©2007 Hewlett-Packard Development Company, L.P.

PUBLICIS HP IPG 008 07

GAGAN update

An insight into the steps ahead

Dr Arjun Singh, Dr SK Saraswati and Dr K Ramalingam

This paper is an update of the GAGAN status presented at NSP meeting on May 8-19, 2006 held at Brussels, Belgium and also provides the future roadmap of the project. GAGAN will provide augmented information for satellite navigation to the aircraft flying within Indian Flight Information Regions (FIRs), which consists of seven boundaries. India is situated inthe vicinity of equator. In the equatorial region the ionospheric variations are very predominant which affect the GPS as well GEO signals. It has therefore been decided to go for unique regional Iono -Tropo model over Indian airspace after collecting TEC data over an extended period of time from 20 TEC stations which have been established for the purpose. After analyzing the data for twenty months, it has been observed that seven more TEC stations are needed in the equatorial anomaly region where equatorial anomaly is very high, to develop the model more accurate.

Implementation Timescale

Technology Demonstration Systems (TDS): This phase requires implementation of a minimum configuration system which would demonstrate the capability of the system to support up to precision approaches over limited region of the Indian airspace and will serve as proof of concept. The performance objective of this system is to meet the ICAO SARPs requirements. The TDS will consist of eight Indian Reference Stations (INRES), an Indian Mission Control Center (INMCC), two Indian Land Uplink System (INLUS), Space segment, required communication links and necessary software for navigation and communication during the TDS phase. The installation of the ground segment has been completed and Preliminary Site Acceptance Test (PSAT) has been carried out with the help of satellite emulator. In the scope of this phase second frequency L5 is being incorporated in both space and ground segments. Initial Experimentation Phase (IEP) has been merged with TDS to make the system more usable and now it is called TDS –Extended.

Final Operational Phase (FOP): during this phase, the GAGAN program will be matured. Extensive tests would be carried out to establish the stability of various elements of the system as a whole. The system will be put in extensive use for its evaluation with respect to ICAO SARPs. Certification and validation of the system will be completed before declaring the system operational. The FOP will be completed by the year 2008

Current status of GAGAN

Infrastructure for installation of INRES at Delhi, Kolkatta, Guwahati, Portblair, Ahmedabad, Banglore, Jammu and Trivanthapuram is in place. All eight INRES equipment have been installed and seven stations have been linked through Optical Fiber Cable (OFC) to INMCC for connectivity test. All the station data are being recorded at INMCC, Banglore. The installation of GPS-TEC at all twenty stations has been completed. Ionospheric data from twenty TEC stations is being analyzed by number of Indian universities and R&D institutions involved in ionospheric studies for the development of an IONO-TROPO model that will be suitable for Indian airspace. Based on the results of extensive analysis, it is proposed to install seven more GPS-TEC receiver in the mid region of India due to Equatorial Indian Anomaly (EIA) where ionospheric variation is very high. It is further observed that scintillation is very active upto 60° elevation based on thirty months data.

Infrastructure for INMCC and INLUS at Banglore is in place and installation of GAGAN equipment have been completed. Infrastructure for providing standby connectivity through V-sat from all INRES to INMCC is in progress, which will be completed by December 2006. A geo-stationary payload in C-Band and L1 and L5 frequencies will be carried by GSAT-4 (fabricated and developed by ISRO) placed at 82 ° E. GSAT-4 is scheduled for launch by July 2007.

At present GAGAN ground segment is under integration test and data collection at INMCC Banglore has begun. The possibility for hiring of INMARSAT 4F1 navigation transponder is being explored for integration of GAGAN ground system, to complete of Final Site Acceptance Test (FSAT) and conducting user level testing of GAGAN Signal-In-Space (SIS)

Technology support of development nd maintenance of GAGAN

ISRO in association with the AAI will be developing the entire system through all the stages of TDS, IEP and FOP. ISRO will continue to provide technology support, maintenance and replenishment of the space segment of the system, as and when required, to maintain the robustness of the system.

Results

The PSAT result of the GAGAN TDS-Extended as follows

At present GAGAN ground segment is under integration test and data collection at INMCC Bangalore

- The TDS phase is to demonstrate the expected vertical and horizontal positional accuracies over 95% of the time with the associated Time-to-alarm (TTA) capability.
- Results were better than 7.6 meters accuracies in both vertical and horizontal over 95% of the time within the perimeter of the reference stations.
- Using type 62 (test) message, the TTA was better than 6.2 seconds
- Results were well within the exit criteria of PSAT
- Perimeters of INRES sites too exhibited good performance

The meeting is requested to take note of the PSAT result of GAGAN.

Dr Arjun Singh
Joint General Manager
Airports Authority of India

Dr S K Saraswati
Executive Director (CNS-P)
Airports Authority of India

Dr K Ramalingam
Chairman, Airports Authority of India

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.

EU, Morocco seal deal on Galileo

The European Union (EU) and Morocco signed an agreement in Brussels for cooperation on the European satellite radio navigation program Galileo. The two sides will join hands in a wide range of activities, including scientific research and training, industrial cooperation, trade and market development, standards, certification and regulatory measures. Morocco is the seventh international partner of the EU on the Galileo global positioning system. The 25-nation bloc has signed cooperation agreements with the United States, China, Israel, Ukraine, India and South Korea. *http://english.people.com.cn*

Czechs seek Galileo project

The Czech Republic is fighting hard to host Europe's ambitious satellite navigation program Galileo — a project that would relieve the continent's dependence on the U.S. Global Positioning System — but it faces stiff competition from nearly half of the European Union. The Czech Republic and 10 other countries — including Germany, France and Britain — have applied to oversee the program dubbed the Galileo Supervisory Authority (GSA). Winning the bid has become a prestigious matter for many countries, if for no other reason than it will serve up to 400 million people. But the project will also bring hundreds of highly skilled and high-paying jobs when it is launched in 2008. *www.praguepost.com*

NovAtel Inc. accepted as full member of Galileo services

NovAtel Inc., Canada, a precise positioning technology company, announced that it has been accepted as a Full Member of Galileo Services, the first company outside Europe to be inducted into this leading group of organizations. *www.novatel.com*

Commission starts satellite navigation discussion with green paper

The European Commission has published a Green Paper on satellite navigation applications that poses questions on which applications should be developed, and what the public sector's role should be. The Green Papers outlines a number of potential applications, and then asks stakeholders to indicate their area of interest and then give their opinion on the most important related issues. These include: measures to accelerate market introduction, the legal and regulatory framework; the role of the pubic authorities; market perspective; sensitivity to costs; certification; and integration with communications systems. *http://cordis.europa.eu*

China to use Galileo satellite navigation system

The European Union's Galileo satellite navigation system is expected to be operational in China in 2008. The 30-satellite system, with a navigational fix accurate to within one meter, will provide safe, reliable and accurate navigational information for Chinese users in fields of civil aviation, railway, waterway and road transportation, according to a Sino-EU technology cooperation symposium in Nanjing, capital of east China's Jiangsu Province. *http://news.xinhuanet.com*

SUBSCRIPTION FORM

YES! I want my Coordinates

I would like to subscribe for (tick one)

☐ 1 year	☐ 2 years	☐ 3 years
12 issues	24 issues	36 issues
Rs.1200/US$80	Rs.2100/US$145	Rs.2700/US$180

SUPER saver

First name ....

Last name ....

Designation ....

Organization ....

Address ....

....

City .... Pincode ....

State .... Country ....

Phone ....

Fax ....

Email ....

I enclose cheque no ....

drawn on ....

dated .... towards subscription

charges for Coordinates magazine

in favour of cGIT.

Sign .... Date ....

Mail this form with payment to:

Coordinates – cGIT
28A Pocket D, SFS
Mayur Vihar Phase III
Delhi 110 096, India

If you'd like an invoice before sending your payment, you may either send us this completed subscription form and we'll bill you, or send us a request for an invoice at **iwant@mycoordinates.org**

North pole keeps moving south

Changing Latitude and Regional Cooling

Muneendra Kumar

In 1900, the International Latitude Service started to monitor the wobbling and wandering of the North Pole. Since that year, the North Pole has been moving south. In everyday terminology, it has moved secularly on the Earth's surface in the only direction it knows, i.e., south. The total motion has been about 13.5 meter over the past 100+ years, which in other words amounts to an amazing rate of 13 cm per year or about 1 cm per month. This would mean that South Pole has the "opposite" motion. Checking the data sets further, the 100+ year journey has been a southerly zigzagging sojourn, where at present the Pole's path is along 333° East Longitude.

From the above, my interpretations are:

Changing Latitude – The southerly moving of the North Pole would directly be changing our geodetic latitude by about ± 0.005 arcsec/year. Of course, if the latitude would increase in an area of the Earth, it would decrease on the corresponding opposite area.

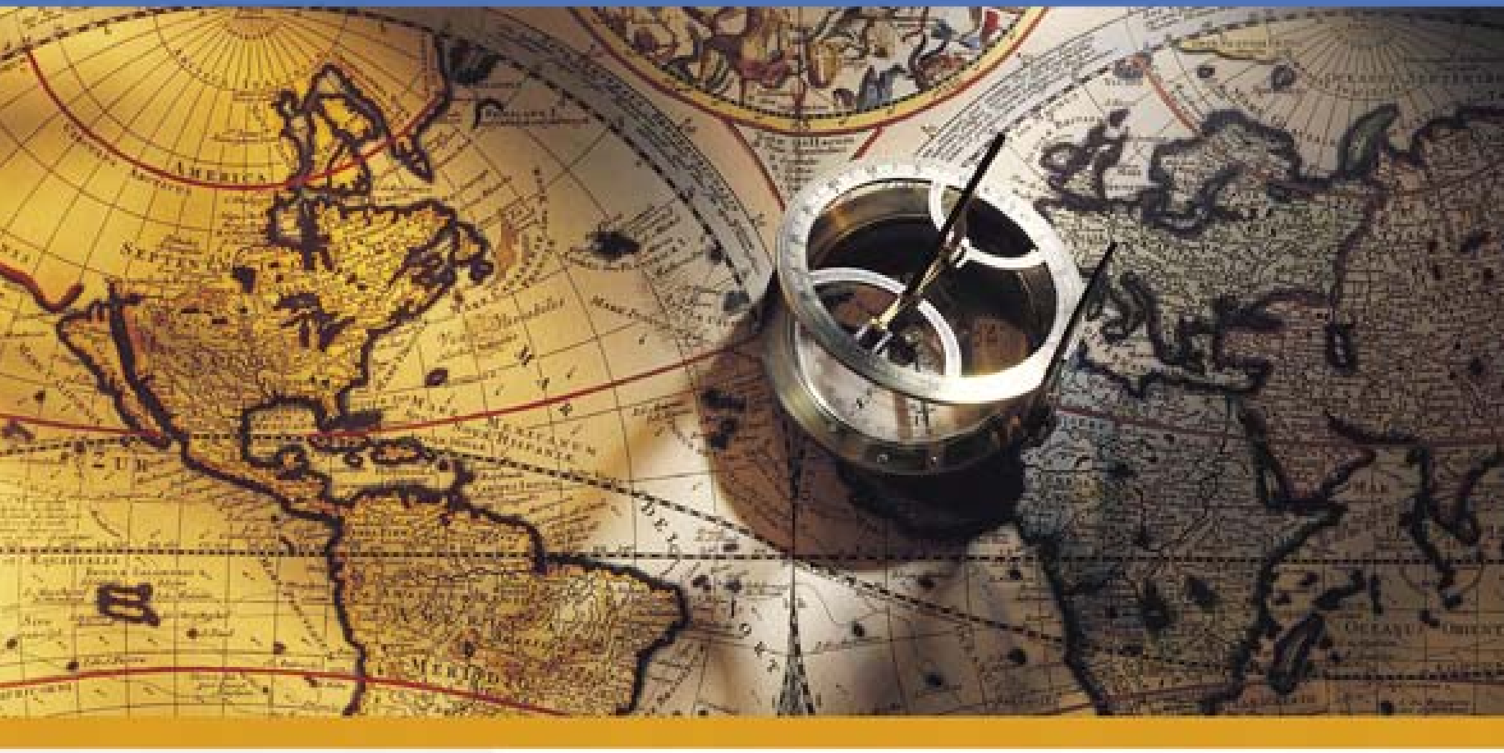
Regional Cooling or Warming - From the 14 m total motion in the past century and considering the present rate, it is expected that North Pole would be another 6 to7 m further south over the next 50 years. In the northern hemisphere, this would simply mean that North Pole is closing on towards North America and Greenland and thus should be "cooling" them. For the Siberia, the opposite would be happening.

In the southern hemisphere, the South Pole would be moving further north and closing on Australia. Thus, southern Australia would also be "cooling".

For the effect on our "Good Coordinates", I, as a geodesist, am sure of the interpretation. However, I have a query to the scientists researching global warming whether they have taken into consideration the impact on regional weather due to this natural phenomena.

Muneendra Kumar Ph.D is Chief Geodesist (Retired), US National Geospatial-Intelligence Agency, **munismk@yahoo.com**

Discover Magellan



Next Generation High-Tech Mobile Survey and Mapping Solutions

Thales Navigation is now Magellan® and continues the tradition of high-quality survey and mapping GPS/GNSS solutions now under the Magellan Professional brand.

Discover the next generation of high-tech mobile survey and mapping solutions, now under a new name – Magellan®. Magellan was the first to circumnavigate the globe and discover the world for those who came after. Thales Navigation is now Magellan and we're blazing our own trails with high-quality survey and mapping GPS/GNSS solutions now under the Magellan Professional brand.

Known for high accuracy, complete mobility, superior flexibility and ease-of-use, Magellan Professional products offer the fast, reliable results that every surveyor and GIS professional needs to stay ahead of the industry and increase revenue.

The new .Net generation of survey solutions from Magellan Professional features Z-Max®.Net with NTRIP, VRS and FKP network communication, and MobileMapper® CE for accurate and cost-effective mobile mapping and GIS. ProMark™3 now with added accuracy and significantly faster data collection, builds on the best-selling single-frequency GPS family on the market.

Contact us today and discover Magellan.

For more information:

France(HQ) +33 2 28 09 38 00
China +86 10 65 66 98 66
APAC +65 6235 3678

professionalsales@magellangps.com
www.pro.magellanGPS.com

THALES | MAGELLAN® PROFESSIONAL

©2006 Magellan Navigation, Inc. Magellan, Z-Max, ProMark, and MobileMapper are trademarks of Magellan Navigation, Inc.

Acquisition sensitivity limits of new civil GNSS signals

The importance of sensitivity for consumer GNSS receivers is discussed in view of location based services and emergency call positioning

Seppo Turunen

Location based services (LBS) are a rapidly growing field of wireless data services that can be accessed through a mobile phone equipped with a GNSS receiver. Some of the services are intended for outdoor use while others are suited for use in urban and indoor areas. It is therefore likely that subscribers will expect these services to be available throughout the coverage area of the mobile telephone network. Regulators, who are mainly interested in the positioning of emergency calls, have likewise established requirements for mobile phones that have a built-in GNSS receiver. According to the requirements, the GNSS receiver must successfully acquire and track satellite signals under measurement scenarios that simulate heavy signal attenuation. Since the processing load for signal acquisition has a strong inverse dependency on signal power, acquisition is rapidly becoming the most demanding task computationally of modern consumer GNSS receivers.

The challenge of signal acquisition does not depend only on the received signal power but also on the availability of reference time, reference frequency, satellite ephemeris information, and an initial location estimate. When available, they allow the receiver to calculate estimates for Doppler shifts and, if sufficiently accurate, for code phases. The estimates allow the receiver to reduce search ambiguity and the time and effort needed for acquisition. The reference time and reference frequency could, in principle, be obtained from a good crystal oscillator. However, the crystal oscillator of a consumer grade receiver is often prone to temperature drift and other instabilities. GNSS receivers that are integrated into a mobile phone have a high-quality frequency reference available from the cellular network. If the so-called assisted GNSS (A-GNSS) functionality is enabled, the receiver can also obtain time, location and satellite ephemeris information from the network. The required transactions are specified in all mobile telephone standards but the functionality has not, unfortunately, been implemented in all networks. The accuracy and content of the information is also dependent on the network.

Trends in receiver architecture

To successfully search and detect a GNSS satellite signal in an area of heavy fading it is often necessary to use an integration time of one second or more. This is true in particular when oscillator instability, signal modulation or receiver movement limits coherent integration time. Under such circumstances, a serial search would proceed extremely slowly except when accurate prior information about the code phases and Doppler frequencies is available. Modern consumer GNSS receivers are therefore more and more often equipped with a means of efficient parallel acquisition. A typical acquisition processor consists of a bank of time-domain matched filters for code phase searching and a digital Fourier transformer for frequency searching.

A recent trend is to use software-based acquisition and to perform the matched filtering in the frequency domain, which is computationally efficient. This kind of software acquisition is typically carried out off-line and the required transforms between the time and frequency domain are performed with FFT.

The processing of a delay-frequency bin for satellite acquisition is conceptually shown in Fig. 1. A stream of complex-valued base-band samples from the receiver RF section is multiplied with a locally generated replica signal to eliminate – or wipe off – the Doppler frequency and ranging code, leaving a complex-valued DC signal. The DC signal is then integrated coherently, squared, and added to a memory location dedicated to the specific combination of Doppler frequency and code delay. This sequence of operations, which constitutes one non-coherent processing step, is performed for each delay-frequency bin in parallel and repeated one or several times. Finally, a decision strategy is applied to the contents of the

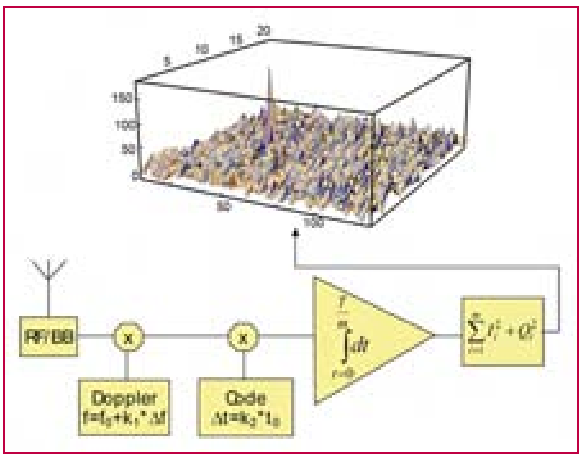


Figure 1. Receiver structure for acquisition.

memory and a conclusion made about the existence of a satellite signal in one of the bins. If there is a known data modulation on the signal, it can also be wiped off. The wipe-off operations are linear so that their order of execution can be freely changed without effecting the end result, which is useful when optimising the HW implementation. Practical considerations, such as the availability of special signal processing elements, have resulted in widely different implementation architectures.

Numerous studies have been published about sequential acquisition strategies where the same hardware is allocated on different search bins at different times. An element frequently present in sequential strategies is multiple dwelling, where some bins are processed repeatedly to verify the acquisition results. Sequential strategies implicitly assume that acquisition performance is limited by the processing capacity. However, the rapid evolution of digital hardware is making the assumption less relevant. In fact, commercial receivers already contain real-time acquisition processors that can handle tens of thousands of delay-frequency bins in parallel, and SW receivers operating off-line with sample streams stored in memory do not even have strict hardware limitations. It is therefore interesting to know how acquisition performance is bounded when processing restrictions are removed and only physical limitations apply. It turns out that acquisition sensitivity then becomes heavily dependent on the length of the ranging code and on the availability of assistance information, a fact that has not been fully appreciated in the GNSS literature.

New civil GNSS signals and their acquisition strategies

The short C/A code was dedicated for acquisition and the longer P(Y) code for tracking in the original GPS specification. There is no similar division in the newer L1C [IS-GPS-800], L2C [Fontana] and L5 [IS-GPS-705] civil signal specifications or in the Galileo OS [GJU] signal specification. Instead, all component signals have fairly long ranging codes and some of them also have high bit rates. These characteristics are likely to make acquisition difficult due to the resulting expansion of the search space and reduction of bit energy. The new specifications also include pilot signals that take up a significant fraction of the transmitted power. While it is thinkable that the unmodulated pilots are useful for tracking, it is questionable whether they can be used in acquisition due to their extremely long cycle lengths.

Table 1. shows the code lengths and other parameters of some present and future civil GNSS signals. The shortest ranging code belongs to the GPS L1 C/A signal and the longest to the GPS L2C pilot signal, the difference being approximately three orders of magnitude. Both codes are shift-register generated sequences that do not have a discernible substructure. As another example, the proposed Galileo L1 OS pilot signal has a concatenated ranging code consisting of a primary code with 4092 elements and a secondary code with 25 elements. Its cycle length is the product of the lengths of the component codes, i.e. 102300 elements.

The size of the acquisition search space is the product of four factors: the code length of the ranging code, the number of frequency search bands, the time domain over-sampling ratio, and the frequency domain over-sampling ratio. The number of frequency search bands is proportional to the coherent integration time since the latter is inversely related to the receiver bandwidth. In order to avoid code self-noise, the coherent integration time should normally be an integer multiple of code cycles. In the case of the GPS L2C pilot signal, this means that the shortest possible coherent integration time is 1.5 seconds. The coherent integration time for the GPS C/A signal is limited by data modulation to about 20 ms. It follows that the number of frequency search bands needed for the GPS L2C pilot signal is about 100 times larger than that needed for the GPS C/A signal, and further, that the size of the search space for the GPS L2C pilot signal exceeds that for the GPS L1 C/A signal by five orders of magnitude.

Theoretical and practical limitations

A useful insight into parallel acquisition can be gained by examining the statistics of noise bins in the search space. It is well known that the squaring and subsequent summing of *m* independent complex zero-mean Gaussian variables results in a central chi-square distributed variable with 2*m* degrees of freedom [Proakis]. This is exactly the process that produces the noise bin values when there are m coherent integrations and when the input is thermal noise. Assuming a constant total reception time and an input power that corresponds to a noise variance equal to σ2 at both integrator outputs when m is one, the cdf of a noise bin for an arbitrary m is

$$F(x) = \left(\frac{1}{2\sigma^2}\right)^m \frac{1}{\Gamma(m)} \int_0^x t^{m-1} \exp\left(-\frac{t}{2\sigma^2}\right) dt \quad (1)$$

Table 1. Present and future GNSS signals.

	DATA CHANNEL			PILOT CHANNEL	
	Code length [elements]	Symbol length [ms]	Chip rate [10^6/s]	Code length [elements]	Chip rate [10^6/s]
GPS L1 C/A	1023	20	—	—	—
Galileo L1	4092	4	1.023	25*4092	1.023
GPS L2C	10230	20	0.5115	767250	0.5115
Galileo E5B	4*10230	4	10.23	100*10230	10.23
GPS L5	10*10230	10	10.23	20*10230	10.23
Galileo E5A	20*10230	20	10.23	100*10230	10.23

The related mean value of the distribution is $2\sigma^2$ and the standard deviation is $2\sigma^2/\sqrt{m}$.

Since signal detection is critically based on the highest noise bin, the relevant probability distribution is not that of an individual noise bin but that of the maximum of all noise bins in the search space. The cdf of the latter distribution can be written by raising the cdf of the former distribution to the power of n, n being the total number of noise bins:

$$\Pr(x_i \le x, i = 1 \cdots n) = F^n(x) \quad (2)$$

Extreme value theory (EVT), a branch of mathematics developed by Fisher, Tippett, Gumbel and others during the 20th century, proves that the limiting distribution F*n* of the maximum of *n* i.i.d. random variables, when n tends to infinity, has one of three possible functional forms depending on the tail of the parent distribution. For the chi-square distribution and other distributions with an exponentially decreasing tail, the limiting distribution has the double exponential form

$$\lim_{n\to\infty} F^n(x) = F_n(x) = \exp(\exp(\alpha_n(x - u_n))) \quad (3)$$

where the coefficients u_n and α_n are defined by the equations

$$F(u_n) = 1 - \frac{1}{n} \quad (4)$$

and

$$\alpha_n = nF'(u_n) \quad (5)$$

The approximation

$$u_n \approx \frac{2\sigma^2}{m}\left(\ln\left(\frac{n}{\Gamma(m)}\right) + (m-1)\ln\ln\left(\frac{n}{\Gamma(m)}\right)\right) \quad (6)$$

for the chi-square distribution can be obtained from an expression given by Gumbel [Gumbel] for the gamma distribution. Numerical evaluation shows that the approximation is fairly accurate for values of m up to five or six. Substituting (6) and (1) into (5) gives

$$\alpha_n \approx \frac{m}{2\sigma^2}\left(1 + (m-1)\frac{\ln\ln\left(\frac{n}{\Gamma(m)}\right)}{\ln\left(\frac{n}{\Gamma(m)}\right)}\right)^{m-1} \quad (7)$$

The double exponential distribution (3) has the mean value

$$\bar{x}_n = u_n + \frac{\gamma}{\alpha_n} \quad (8)$$

and the standard deviation

$$\sigma(x_n) = \frac{\pi}{\sqrt{6}} \cdot \frac{1}{\alpha_n} \quad (9)$$

where $\gamma = 0.5772\ldots$ is the Euler constant. Substituting (7) into (8) and (9) gives for the mean

$$\bar{x}_n \approx \frac{2\sigma^2}{m}\left[\ln\left(\frac{n}{\Gamma(m)}\right) + (m-1)\ln\ln\left(\frac{n}{\Gamma(m)}\right) + \gamma \Big/ \left(1 + (m-1)\frac{\ln\ln\left(\frac{n}{\Gamma(m)}\right)}{\ln\left(\frac{n}{\Gamma(m)}\right)}\right)^{m-1}\right] \quad (10)$$

and for the standard deviation

$$\sigma(x_n) \approx \pi\sqrt{\frac{2}{3}}\frac{\sigma^2}{m} \Big/ \left(1 + (m-1)\frac{\ln\ln\left(\frac{n}{\Gamma(m)}\right)}{\ln\left(\frac{n}{\Gamma(m)}\right)}\right)^{m-1} \quad (11)$$

When only one coherent integration is involved, (10) and (11) simplify to

$$\bar{x}_n \approx 2\sigma^2(\ln(n) + \gamma) \quad (12)$$

and

$$\sigma(x_n) \approx \pi\sqrt{\frac{2}{3}}\sigma^2 \quad (13)$$

It can be seen from (10), (11), (12) and (13) that the mean of the maximum of the chi-square distributed noise bins has a logarithmic or slightly stronger than logarithmic dependency on the size of the search space, while the standard deviation of the maximum is nearly constant. In other words, the graph of the probability density function of the noise maximum maintains its width but is shifted horizontally when *n* changes. This means that signal detection thresholds also have to be shifted in order for error probabilities to remain constant. The consequence of this is that the receiver acquisition sensitivity is lower when the size of the signal search space is larger, the required signal power being approximately proportional to the logarithm of the size of the space.

In an earlier contribution [Turunen] the author derived an expression for the false acquisition probability in a scenario where a satellite signal is known to be present and the receiver simply chooses the highest peak in the search space. With the noise power assumption made above and with a signal power such that the squarer output is equal to *E* when *m* is one, the false acquisition probability for an arbitrary *m* was found to be

$$P_{fa} = 1 - \int_0^\infty [F(x)]^n g(x)\,dx \quad (14)$$

where

$$g(x) = \frac{m}{2\sigma^2}\left(\frac{mx}{E}\right)^{\frac{m-1}{2}} e^{-\frac{E+mx}{2\sigma^2}} I_{m-1}\left(\frac{\sqrt{mxE}}{\sigma^2}\right) \quad (15)$$

is the pdf of the non-central chi-square distribution obeyed by the signal bin. The last term in (15) is the modified Bessel function of the first kind of order *m*-1. Substituting (1) and (15) into (14) and making the substitution $u = mx/\sigma^2$ leads to

$$P_{fa} = 1 - \frac{1}{2}\int_0^\infty \left(\frac{u}{E/\sigma^2}\right)^{\frac{m-1}{2}} e^{-\frac{E/\sigma^2+u}{2}} I_{m-1}\left(\sqrt{\frac{uE}{\sigma^2}}\right) P\left(m, \frac{u}{2}\right)^n du \quad (16)$$

where

$$P(a,x) = \frac{1}{\Gamma(a)}\int_0^x e^{-t}t^{a-1}\,dt \quad (17)$$

is the incomplete gamma function.

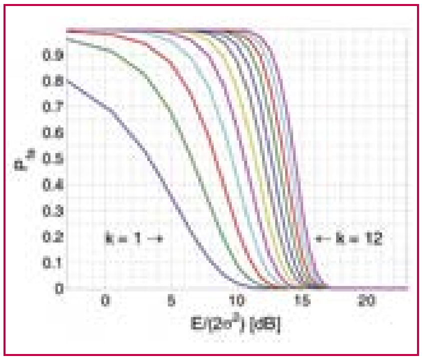


Figure 2. P_{fa} **as a function of** $E/(2\sigma^2)$ **for** $m = 1$ **and** $n = 10^k$**.**

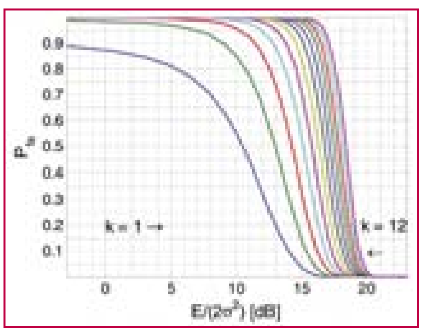


Figure 3. P_{fa} **as a function of** $E/(2\sigma^2)$ **for** $m = 50$ **and** $n = 10^k$**.**

NOT JUST PERFECTLY MATCHED...
MADE FOR EACH OTHER.
THE CHOICE IS CLEAR

Trimble® R6 GPS System Key Features

- A complete Integrated Surveying™ system seamlessly supporting you from field to office
- Trimble GPS technology with an R-Track™ option for GLONASS support
- Built on years of industry-leading surveying technology and system design

Introducing the Trimble® R6 GPS System.

A new advanced Trimble GPS system is now at your fingertips—rugged and ready to work as hard as you do. The Trimble R6 GPS receiver integrates seamlessly with the Trimble TSC2® controller and powerful Trimble field and office software to bring you a complete solution for effortless, efficient surveying. Together the components are greater than the sum of their parts. Flexible options, such as Trimble R-Track technology for GLONASS support and internal radio upgrades, let you fine-tune your system to match your unique needs. Learn more today about the seamless system integration of the Trimble R6 GPS system.

Contact your nearest Trimble sales office today for more information. Or, visit www.trimble.com/trimbler6

India:
+91-124-425 6819 Phone
Email: trimble_support@trimble.com

Asia-Pacific:
+65-6348-2212 Phone
Email: trimble_support@trimble.com

Trimble.

www.trimble.com

©2006, Trimble Navigation Limited. All rights reserved. Trimble and the Globe & Triangle logo are trademarks of Trimble Navigation Limited registered in the United States Patent and Trademark Office.

Numerical examples

Fig. 2 shows the probability of false acquisition from (16) as a function of $E/(2\sigma^2)$ for several values of n when $m = 1$. Due to the identity

$E/(2\sigma^2) = PT/(FN_0)$, (18)

where P is the signal power at base-band input, T is the total reception time and F is the noise figure, $E/(2\sigma^2)$ can be interpreted as the ratio of signal power to noise spectral density at the receiver base-band input when T is one second. Fig. 3 is otherwise similar except that $m = 50$. It can be seen from the figures that when either m or n varies within the chosen limits, the sensitivity changes by approximately five decibels.

The width of a frequency search band is approximately two thirds of the inverse of the coherent integration time [Kaplan], such that the number of frequency bands is

$N_f = 1.5 \times BT/m$, (19)

where B is the total frequency search range. The size of the search space, which includes the n noise bins and the one signal bin, is the product of N_f and the length of the ranging code when no oversampling is assumed. Due to (19), n and m are therefore inversely related. Fig. 4 shows the P_{fa} plots for seven pairs of m and n that exhibit this relationship. It is assumed that T is one second, B is 12 kHz and the code length is 1,023 elements. The figure shows that the net effect of increasing the number of coherent integrations is a reduction in sensitivity.

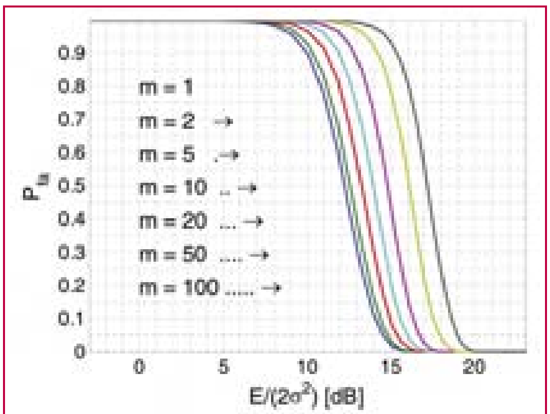


Figure 4. P_{fa} as a function of $E/(2\sigma^2)$ when $n = 1.5 \times 1023 \times 12{,}000/m$-1.

Fig. 5 illustrates the effect of frequency uncertainty on the false acquisition rate when (19) applies. There are two groups of curves, one for $m = 1$ and another for $m = 50$, and seven frequency search ranges from 100 Hz to 15000 Hz. The code space uncertainty is 1,023 and T is one second. It may be observed that the sensitivity impact of changing the number of coherent integrations is about 4 dB and that of varying the frequency search range about 2 dB.

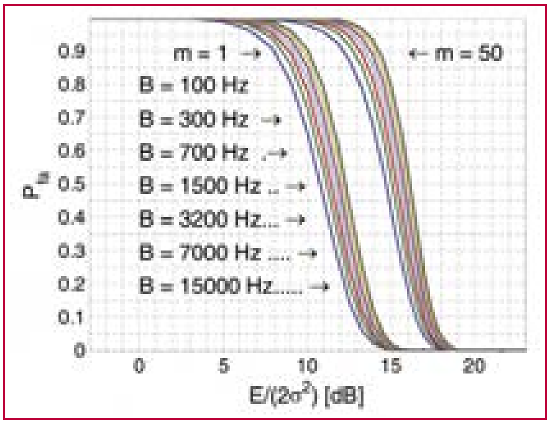


Figure 5. P_{fa} as a function of $E/(2\sigma^2)$ for m = 1 and m = 50 when $n = 1.5 \times 1023 \times B/m$.

Fig. 6 shows how sensitivity depends on the code length Nc in an example where the coherent integration length is equal to Nc code elements and the total reception time is a fixed number of code elements, 106 in this case. Taking (19) into account it follows that $n = 1.5\ BTN_c^2/106$. It is further assumed that there is no oversampling, B is 12 kHz and T is one second. The figure shows that sensitivity becomes higher when the code length is increased. This happens regardless of a simultaneous expansion in the search space.

Finally, Fig. 7 shows six P_{fa} plots that are motivated by six existing or proposed GNSS signals. The signals with some of their parameters are listed in Table 2. The number of delay search phases is based on the assumption of taking one sample per code element. For the GPS L2C pilot signal, the correct figure is twice the number of code elements since the signal is time-multiplexed with a data signal. For the Galileo L1 pilot signal, the number of delay search phases is the product of the lengths of a BOC (bi-phase) code, a primary ranging code, and a secondary ranging code. For all signals, the frequency uncertainty bandwidth B is assumed to be 12 kHz. The reception time T is chosen to be 1.5 seconds according to the coherence time of the GPS L2C signal which is the longest in the table. The number of coherent integrations was obtained from assuming that the coherent integration time is equal to the coherence time of the signal. The number of frequency search bands is calculated from (19).

Based on the plotted results, the attenuation margin corresponding to a P_{fa} of 10% and a noise figure of 4 dB is shown in the rightmost column of the table. The margin was calculated by subtracting the required power obtained by solving P from (18) from the nominal signal power. Shown in the table is also the post-detection S/N ratio, defined here as the difference of the mean value of the signal bin, $2\sigma^2+E/m$, and the mean value of a noise bin, $2\sigma^2$, divided by the latter.

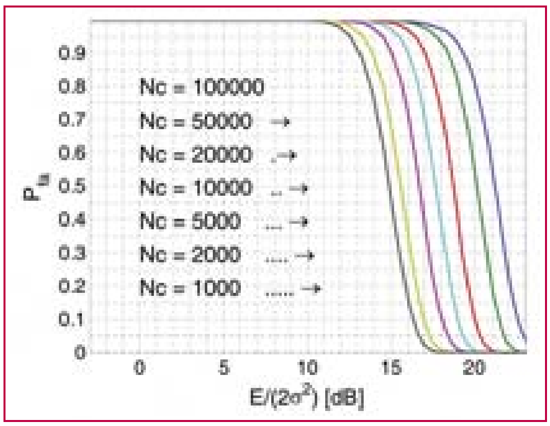


Figure 6. P_{fa} as a function of $E/(2\sigma^2)$ for $m = 10^6/N_c$, $n = 1.5\ BTN_c^2/10^6$, B=12 kHz and T=1.

Table 2. The GNSS parameters for Fig. 7.

	Delay search phases	Coherence length [chips]	Chip rate [1/s]	Nominal power [dBm]	Coherent integr-ations	Frequency search bands	Size of search space	E/2σ2 [dB] Pfa=0.1	Post-detection S/N [dB] Pfa=0.1	Attenuation margin [dB] Pfa=0.1
GPS L2C pilot	2*767250	767250	5.12E+05	-133.0	1.00	27000	4.14E+10	15.4	15.4	23.4
Galileo L1 pilot	2*25*4092	102300	1.02E+06	-130.0	15.00	1800	3.68E+08	16.9	5.1	24.9
Galileo E5A pilot	100*10230	1023000	1.02E+07	-128.0	15.00	1800	1.84E+09	17.1	5.3	26.7
GPS L1 C/A	1023	20460	1.02E+06	-127.7	75.00	360	3.68E+05	18.2	-0.6	25.9
GPS L5 pilot	20*10230	204600	1.02E+07	-127.9	75.00	360	7.37E+07	19.0	0.2	24.9
Galileo L1 data	2*4092	4092	1.02E+06	-130.0	375.00	72	5.89E+05	21.2	-4.5	20.6

As seen from Table 2, the required value of $E/(2\sigma^2)$ is higher when the number of coherent integrations is larger. This is obviously due to the fact that the length of the coherent integration period is inversely proportional to the number of integrations, which leads to a lower post-detection S/N ratio when the number is larger. The fact that the reduction in the post-detection S/N ratio is not reflected as a higher false acquisition rate would suggest that the simultaneous reduction in the size of the search space has a compensating effect. It should be kept in mind, however, that the post-detection S/N ratios do not fully characterize the signal distributions in the search space.

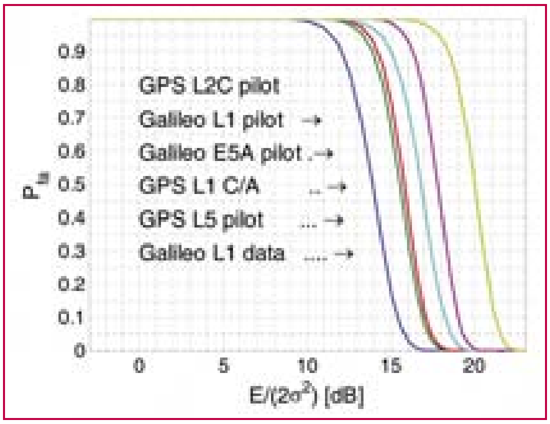


Figure 7. P_{fa} as a function of $E/(2\sigma^2)$ for the examples in Table 2.

Conclusion

The importance of sensitivity for consumer GNSS receivers was discussed in view of location based services and emergency call positioning. The dependence of acquisition sensitivity on the size of signal search space was discussed in the context of an ideal parallel acquisition receiver. The discussion was motivated by the fact that parallel acquisition is gaining popularity in commercial receivers due to growing performance requirements and due to improvements in signal processing electronics. To characterize noise distributions in very large search spaces, results from extreme value statistics (EVT) were used to show, among other things, that the mean of the noise maximum is approximately proportional to the logarithm of the size of the search space. An analytic expression from an earlier publication was used to plot false acquisition probabilities for acquisition scenarios with different numbers of coherent integration steps and frequency search bands. The expression was also applied to analyse the acquisition properties of the chosen GPS and Galileo signals. The results indicate that the best achievable acquisition sensitivity depends not only on signal power and coherence time but also to a significant extent on the size of the search space.

References

- IS-GPS-800, Navstar GPS Space Segment / User Segment L1C Interfaces, GPS Navstar JPO, 19. April 2006.
- R.D. Fontana, W. Cheung, P.M. Novak, and T.A. Stansell, Jr., "The new L2 civil signal," ION GPS 2001, pp. 617–631, 11–14 September 2001.
- IS-GPS-705, Navstar GPS Space Segment / User Segment L5 Interfaces, GPS Navstar JPO, 5. January 2005.
- L1 band part of Galileo Signal in Space ICD, http://www.galileoju.com, Galileo Joint Undertaking (GJU), 2005.
- J.G. Proakis, Digital Communications. McGraw-Hill, 1995.
- E.J. Gumbel: Statistics of extremes.375pp. Dover publications, 2004.
- S. Turunen, "Combinatorial loss in satellite acquisition," ION GNSS 2005, Long Beach, CA, USA, 13–16 September 2005.
- E.D. Kaplan (ed.), Understanding GPS principles and applications, Artech House Publishers, 1996.

Seppo Turunen is a Principal Technologist at Nokia Technology Platforms. He received a M.Sc. in Electrical Engineering from Tampere University of Technology in 1979. From 1979 to 1988 he was involved in the research and development of industrial process control systems at Valmet Process Automation, Finland. He joined Nokia in 1988 and has since held several positions at Nokia Research Center, Nokia Mobile Phones and Nokia Technology Platforms. His current interests include mobile phone positioning techniques using assisted GNSS, cellular network measurements and motion sensors.

KCS TraceME

GPS/GPRS/SMS Module

Why buy TraceME products?

1. monitor your fleet with GPS/GPRS/SMS
2. monitor your staff in any country
3. send messages to/from your people
4. monitor your machines wireless via internet
5. update machines worldwide with your PC
6. sufficient I/O for sensors etc.
7. iButton auto start safety device
8. guard properties via mini camera
9. unlimited applications possible
10. Dutch design
11. Dutch production and support
12. Satisfied customers:

- IMTECH
- DUTCH POLICE FORCE
- PORTUGUESE FIRE DEPARTMENT
- AGGREKO GENERATORS
- SKYNET MOBILE
- UK GOVERNMENT
- MOTOROLA DUBAI
- AFRICAN OIL COMPANIES
- GERMAN ROADSERVICE
- and many others worldwide

www.TraceME.eu

* All information in this advertisement subject to change. E. & O.E.

TraceME mini SPY camera
watches over your belongings
and transmits pictures via GPRS.
Watch them via your web browser.

Communicate in your car with the office or with
another vehicle via a.o. SMS with the TraceME LCD module.
Secure your vehicle with the help of an iButton start.

(c)KCS BV, Kuipershaven 22, NL-3311AL Dordrecht. Fax: +31 20-5248130 www.TraceME.eu kcs@kcs.tv

Very low price

TraceME application areas

Medical:
Monitoring transport of organs, stem cells, blood, etc. Ambulances and other transports.

Measurement & Control engineering:
Wireless distance control of generators, all equipment with an SPI or RS232-interface. Climate control.

Cold-storage engineering:
Detection of temperatures during cold-storage transport and alarm signals when deviations occur.

Services & Logistics:
Tracing transports:
Busses, cars, lorries, taxis, fire engines, river craft, trailers (also on solar energy)

M2M (machine to machine)
Pilot/control your machines/pumps etc. via the internet without the help of mechanics.

Security/ safety:
Buildings with or without miniature cameras and/or sensors via wireless transmission.

Police:
Various police services have already been equipped with TraceME modules + cameras in various countries.

US National Space Policy

The tone of the NSP is "unilateralist" in terms of the approach

George Cho

The U.S. National Space Policy (NSP) was authorised by President Bush on August 31, 2006. This NSP establishes an overarching national policy that governs the conduct of U.S. space activities and supersedes the 1996 NSP.

The unclassified ten-page summary of the NSP consists of 13 self-contained sections including the principles, goals, guidelines (both general and specific to national security space, civil space and commercial space), international space cooperation, space nuclear power, radio frequency spectrum, orbital debris, effective export policies and space-related security classification

The first part of this review focuses on the principles and goals of U.S. 2006 space policy as these provide the overall rationale to the policy. The second part of this review of the 2006 NSP highlights the context of the policy, a comparison with the previous policy, commentaries of the policy by others and some final observations.

Principles of the 2006 NSP

The seven principles of the NSP include:

1. "The U.S. is committed to the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all humanity. "Peaceful purposes" allow the U.S. to undertake defence and intelligent-related activities in pursuit of national interests;
2. The U.S. rejects any claims to sovereignty by any nation over outer space or celestial bodies, … and rejects any limitations on the fundamental right of the U.S. to operate in an acquire data from space;
3. The U.S. will seek to cooperate with other nations in the peaceful use of outer space to extend the benefits of space, enhance space exploration, and to protect and promote freedom around the world;
4. The U.S. considers space systems to have the rights of passage through and operations in space without interference … purposeful interference with its space systems [is] an infringement on its rights;
5. The U.S. considers space capabilities … vital to its national interests. … The U.S. will: preserve its rights, capabilities, and freedom of action in space; dissuade or deter others from either impeding those rights or developing capabilities intended to do so; take those actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests;
6. The U.S. will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space. Proposed arms control agreements or restrictions must not impair the right of the U.S. to conduct research, development, testing, and operations or other activities in space for U.S. national interests; and
7. The U.S. is committed to encouraging and facilitating a growing and entrepreneurial U.S. commercial space sector … to the maximum practical extent, consistent with national security."

U.S. 2006 NSP Goals

"The fundamental goals of the NSP are to:

- Strengthen the nation's space leadership and ensure that space capabilities are available in time to further U.S. national security, homeland security, and foreign policy objectives;
- Enable unhindered U.S. operations in and through space to defend our interests there;
- Implement and sustain an innovative human and robotic exploration program with the objective of extending human presence across the solar system;
- Increase the benefits of civil exploration, scientific discovery, and environmental activities;
- Enable a dynamic, globally competitive domestic commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national, homeland, and economic security;
- Enable a robust science and technology base supporting national security, homeland security, and civil space activities; and
- Encourage international cooperation with foreign nations and/or consortia on space activities that are of mutual benefit and that further the peaceful exploration and use of space, as well as to advance national security, homeland security, and foreign policy objectives."

The Context of the 2006 NSP

This 2006 NSP completes President Bush's review of all U.S. space policies since 2003. The other four in the series include:

- U.S. Commercial Remote Sensing Policy, April 2003 that provides guidance for, among other things, licensing and operating commercial remote sensing space systems, and foreign access to such systems;
- Vision for Space Exploration, January 2004 that advances scientific, security and economic interests through a robust space exploration program;

- U.S. Space Transportation Policy, December 2004 establishes national policy, guidelines, and implementation actions for space transportation programs; and,
- U.S. Space-based Positioning, Navigation, and Timing Policy, December 2004 that establishes guidance and actions for space-based positioning, navigation and timing programs.

It is evident that such policies are and should be of interest and concern to the geospatial community in general and to precision navigation and coordinates in particular. But, before delving into details, it is also imperative to know what has gone before the NSP to further enhance understanding of the context and background.

Comparisons with the 1996 Policy

The tone of the NSP is "unilateralist" in terms of the approach in regard to access to space and the rejection of new treaties or other limitations on U.S. By comparison, the 1996 policy uses language that is both cooperative and collaborative such as in the words "enhance the security of the U.S. and our allies". Such a tone is evident in a close reading of the "principles" section of both policies.

In regard to arms control, the 1996 document emphasises a "considering" of arms control whereas the NSP makes it clear that the administration is wary of arms control and views it as a possible threat to American space operations. Such an attitude is probably informed by the preoccupation with national security space issues in the new century. Whereas national security was mentioned in two of the five goals in 1996, the same is mentioned in four of the six goals. In the new policy it is clear that international cooperation and arms control are of lesser priority.

The changing emphasis may also be a reflection of a different environment compared to those kinds of issues facing the U.S. space program in 1996. Hence, it is not surprising that national security in space are high on the agenda given that it is now more troubling than before while civilian use of space is in need of greater direction from the U.S. government.

The NSP includes a new section on access to the frequency spectrum, orbit management and interference protection. For instance, the frequency spectrum is now more crowded than it was a decade ago because of greater civilian use. In defence terms there is a greater demand for access, given that there are now more commercial satellites that compete for the use of the spectrum such as the extremely high frequency Ka-band.

The NSP extends the goals of the 2004 Vision for Space Exploration and NASA's new focus on exploration. But, space is not the sole goal of the Agency. The 1996 policy was quite explicit and expansive in regards to statements concerning the enhancement of knowledge of the solar system, and fundamental natural and physical sciences. The statements also included issues such as an understanding of global change and the effect of natural and human influences on the environment; human space flight activities; and space technology development in support of U.S. government needs and economic competitiveness.

Curiously, the NSP however omits to mention the International Space Station nor the Space Shuttle which is the current focus of NASA. Furthermore, the new policy lists only two civil areas of cooperation – exploration programs and Earth observation with the omission of other space science opportunities.

In 1996 Earth science and Earth observation is mentioned over 20 times with an entire section devoted to the subject. In contrast the 2006 NSP mentions this subject only six times. Probably this is a reflection of the growing commercial remote sensing field at that time but which has now matured and no longer requires that degree of attention. However, what remains unexplained is the lack of attention to the study of global change in the NSP. Again, this may be because the subject-matter is no longer the passion nor the portfolio of the Vice President's Office.

A quirk in the NSP is the section on space nuclear power, while much longer than the 1996 version, the focus is on "non-government spacecraft utilizing nuclear power sources". A survey of the players in the field suggests that there are no non-government spacecraft that may be so described. This leaves any reader perplexed about the agenda setting process in policy deliberations.

The NSP will again be in limbo when a new President is elected in 2009 since there will probably then be another new set of policy objectives.

What others say about the 2006 NSP – a selection

Various commentators have published their views of the 2006 NSP. In the October issue of the New Scientist Jeff Hecht restates the emphasis with an article entitled "US takes unilateral stance in new space policy".

The opening statements to the Hecht article observe the more aggressive and unilateral stance than the previous Clinton policy. The NSP flatly rejects new agreements that would limit U.S. testing or use of military equipment in space. There is also stronger language to assert that the U.S. can defend its spacecraft which echoes an air force push for "space superiority" that was made in 2004. This may perhaps be a precursor to a new anti-satellite arms race where robotic spacecraft could approach a satellite to check it out, then sabotage it if the U.S. deems it to be a danger to its interests.

In October, CBC News provides a commentary under the headlines "New U.S. space policy strong on military activity". It said that Washington's new space policy focuses on military capabilities, including rejecting limitations by arms control agreements, entrenching missile defence systems and asserting its right to deny such access to its enemies. While the policy does not specifically mention the weaponization of space, it makes clear that the U.S. will not brook any hindrances in any sphere of its activities there.

International law and treaties prohibit the weaponization of space, for example, the provision in UN Resolution 2222 governing the use of space.

BBC News has provided similar comments in saying that the U.S. had adopted a tough new space policy that rejects any proposals to ban space weapons. But it also reported that the White House has said the policy does not call for the development or deployment of weapons in space.

Leonard David writing in Space.com states that the 'new Bush Space Policy unveiled, stresses U.S. freedom of action'. The new policy supports not only a Moon, Mars and beyond exploration agenda, but also responds to a post 9/11 world of terrorist actions, such as the need for intelligence-gathering internal and external to the U.S.

This is collaborated by a Washington File Staff Writer Cheryl Pellerin who wrote that the U.S. opposes restrictions on use of space and the policy acknowledges new technology, and the importance of space to international commerce.

For the interest of the geospatial community the NSP lists several unclassified facts such as the conduct of satellite photoreconnaissance that includes a near real-time capability, as well as overhead signals intelligence collection. Such activity are used to "image the U.S. and its territories and possessions, consistent with applicable laws, for purposes including, but not limited to, homeland security".

Interestingly, at about the same time the Press Trust of India reported that President A P J Abdul Kalam suggested enacting law to govern the use of outer space and regulate the use of data acquired from remote sensing satellites, particularly of sensitive installations. "We have to have a law of space like the United States", Kalam said addressing the 26th Congress of the Indian National Cartographic Association. While laudable, in practice, the reality is equivocal. For example, one may be unable to get a map of say, Rashtrapati Bhawan, from the Indian Department of Science and Technology even though this might be readily available on Google Earth.

Elsewhere there have been fears and critiques aplenty. Moscow News under the headline 'Russian official says new U.S. space policy will lead to military confrontation' may send shivers in defence departments. This 2006 U.S. space policy has been sharply criticized by Russian space officials one of which views it as a first step toward a serious deepening of military confrontation in space. However, in truth, closer inspection of the article reveals that the commentators have failed to read the NSP in its entirety and are reacting to secondary media reports of the policy.

This observation is further collaborated by James Oberg's November article in Msnbc.com entitled 'An outer-space war of words escalates: Russians overreacting on the basis of overwrought reports on U.S. policy'. Oberg's analysis traces the origins of the misinterpretations to a story in the Washington Post on October 18th by staff writer Marc Kaufman who wrote that the new policy "asserts a right to deny access to space to anyone 'hostile to U.S. interests'". Oberg goes on to say "And that's the way most of the world consequently reported it, usually in quotation marks, without most reporters ever reading the original document."

Those countries that reacted to these statements, including Russia and China, have misread it since the NSP does not deny access but rather that which is to be 'denied' is any hostile action by adversaries. Oberg's plea is that the Russians must be told, and told quickly and credibly, that the press accounts are inaccurate and unworthy of belief – and undeserving of counteraction. "Launch the truth into orbit, and abort the myths – that's the only safe trajectory."

A critique of what the commentators are writing may also be found in Dwayne A. Day's observations in The Space Review. The observations are made by pitting left-leaning newspaper editorial boards and what they emphasise as against commentators on the right side of the political spectrum. Such observations do make interesting reading given that the critiques are of a bland policy document.

Why the quiet release?

The 2006 NSP had been expected for almost two years. It reportedly went through 35 drafts before being finalised (though not unusual for such an important matter). The delay in its release however is unusual because of supposedly internal conflicts between various departments in there roles and responsibilities – Defence, Central Intelligence and the new intelligence bureaucracy. What is interesting is the President Bush signed the unclassified document on August 31st but it was released at the end of the day on Friday October 6th. It has been claimed that this was intended to gather minimal attention. However, as will be noted, the ploy was relatively successful, as the popular media only made comment a week later. But what remains unexplained is why the quiet release and just before a public holiday long weekend.

End Notes

- A copy of the 2006 NSP is available at the following source: http://www.ostp.gov/html/US%20National%20Space%20Policy.pdf
- See the 1996 policy at http://www.fas.org/spp/military/docops/national/nstc-8.htm
- See http://usinfo.state.gov.
- See http://www.fas.org/spp/military/

docops/national/nstc-8.htm

- See http://space.newscientist.com/article/dn10262-us-takes-unilateral-stance-in-new-space-policy.html
- See http://www.cba.ca/technology/story/2006/10/19/tech-usspacepolicy-061019.html.
- See http://news.bbc.co.uk/go/pr/fr/-/2/hi/americas/6063926.stm. For a further analysis of space arms control see also Nader Elhefnawy (2006) 'The National Space Policy and space arms control', in The Space Review at http://www.thespacereview.com/article/755/1.
- See http://www.space.com/news/061007_bush_spacepolicy.html
- See http://usinfo.state.gov/xarchives/display.html.
- Staff Writers (2006) 'Enact space law to govern use of remote sensing data' http://www.spacemart.com/reports/enact_space_law_to_govern_use_of_remote_sensing_data_999.html
- See http://www.mosnews.com/news/2006/11/30/spacecritic.shtml.
- See http://www.msnbc.msn.com/id/15656337/
- Marc Kaufman (2006) 'Bush sets defense as space priority', in http://www.washingtonpost.com/wp-dyn/content/article/2006/10/17/AR2006101701484_pf.html
- See also Ned Potter (2006) "U.S. says 'Keep Out of My Space'" in http://abcnews.go.com/Technology/print?id=2583812
- See Day, D (2006) 'Not really lost in space: the new National Space Policy', The Space Review at http://www.thespacereview.com/article/745/1
- See Theresa Hitchens and Haninah Levine (2006) 'Bush: Space is for soldiers', in http://www.defensetech.org/archives/002837.html where the authors state the view that "the U.S. has taken on the role of a "Lone Space Cowboy".

George Cho
University of Canberra, Canberr, Australia, **George.Cho@canberra.edu.au**

Can use of GPS be legal in India?

A citizen's plea

I am an avid outdoor enthusiast and as such got a very simple GPS handset as a gift from a friend visiting me from abroad. This GPS can simply tell me my location in terms of latitude and longitude anywhere on earth. It can also help me trace back my route if I am lost in say a jungle or desert etc. The device is intended for use outdoors just for fun.

A few friends told me that apparently I need a license to use this device in India. I did some internet based research to find out the truth behind the matter and came across your magazine where you had printed an interview of Mr P K Garg, Wireless Adviser to Government of India, Wireless Planning and Coordination (WPC) Wing, Ministry of Communications and IT, Government of India. Although I was surprised to read that yes indeed I needed a license to operate the device in India, as confirmed by Mr Garg, being a law abiding citizen I decided I must acquire the license before operating it or at least apply for it. This started off a very frustrating process for me of trying to crack the bureaucracy which I am relating below in the hope that it will be read by someone who is authoritative enough to help me out.

I could quite easily locate the website of WPC but could not find out anything written there on the subject of GPS licence. The next thing I did was to call up the deputy wireless advisor to the government of India, whose phone number is prominently mentioned in the contact us section of the WPC website. He directed me to speak to someone else who looks after licensing etc. This gentleman, a very senior advisor to the government of India told me categorically that there is no policy yet on the use of GPS and therefore I can't get a licence. He even asked me as to from where I got this handset since it was a "banned" item. When told that I was getting it as a gift from a friend visiting me from abroad, he asked me not to accept the gift, as it was a "banned" item. His unstated hint was that mere possession of the device is illegal – like an unlicensed gun.

Later I found out from another article in your magazine that DGFT has derestricted GPS and it can now be imported freely without any special permission. In any case it was never a banned item but a restricted one.

I remember in my student days thirty years or so ago we used to need license for listening to radio sets. My father used to maintain the blue coloured book and scrupulously pay the license fees every month at the local post office. Although it was a ridiculous system (no one could ever have found out if we were paying the fee or not) but at least the system was in place. People who wanted to use radio knew how to get the licence.

Now in the year 2007 that law abiding citizen's son is trying to acquire a license for operating a GPS handset and is coming against stonewalls.

My question to you sir is simple – if GPS needs a license to operate in India then what is the procedure for obtaining that license, what forms need to be filled up? Where do I get those forms? I know how to get a driving license, I even know how to get the license for a gun but I don't know how to get the license for operating my GPS.

I am not really getting into the issue of how ridiculous it is to need a license for GPS. I just want to know how to get the license. If Mr Garg says yes one needs a license, he should also let us know how to get it. The WPC website incidentally is an excellent one except that it does not deal with GPS at all. There I also read the various recent changes in the Telegraph Act (by the way, remote controls for operating mobile cranes have been made license free recently). I am hopeful even GPS will be made license free but the question is when? And till then what happens?

Sudipto Roy
sudiptoroy17@gmail.com

Galileo Technology Centre

A data processing facility for monitoring and analysis of Galileo/GNSS services performance

DR H SU, W EHRET, DR H BLOMENHOFER, E BLOMENHOFER

Today Satellite Based Navigation Services play an increasingly important role in modern society. The provision of the navigation, positioning and timing service provided by GPS is widely used. However, the system is under military control, and consequently legal guarantees of operation required by modern business cannot be given. On the other hand the market for GNSS related products is recognised as an important economic factor and service guarantees and liabilities will be needed.

Accordingly, the European Commission (EC) and ESA jointly launched initiatives towards an independent European Galileo satellite constellation and associated augmentations and systems including the integration of the EGNOS service. The Galileo system will comprise state-of-the-art global positioning and timing service, integrity service, search and rescue (SAR) as well as commercial services that are still under study. With the architecture defined so far, Galileo will be interoperable with other services and service guarantees can be offered. Local operators may add a number of local services, such as local differential correction signals or availability augmentations.

The quality of the signals is monitored by the ground segment and corresponding integrity messages are broadcasted via the Galileo satellites for safety-of-life applications. Orbit ephemeris and clock synchronisation are calculated from measurements made by a worldwide network of stations. The space segment consists of a constellation of 30 satellites (27 + 3 in-orbit spares) distributed over 3 orbital planes in MEO altitudes. As the outcome of the In-Orbit-Validation Phase, there will be 4 Satellites and the associated ground segment to provide initial operations from 2008 onward. The Galileo Full Operational Capability is expected to be achieved 2 years later[1].

Based on the Galileo Services there will arise various downstream applications and value added services on global, regional and local levels. It is expected that along with these services there will also arise the need to provide Galileo service performance information and analysis. In the Galileo project it is planned to give to independent regional Galileo Service Centres access to the Galileo Ground Control Centres (via the Service Provision Facility - SPF) as e.g. pointed out in [2].

Thales and NavPos have jointly started an initiative, supported by the German Aerospace Centre (DLR) to develop a technical facility to satisfy these needs and to support the introduction of Galileo worldwide. This development is called GalTeC - Galileo Technology Centre and could be viewed as one of the downstream Galileo Service Centres.

GalTeC mission

The basic scope of GalTeC is to provide services related with the provision of Galileo satellite-only services through the Galileo Operating Company (GOC). However it will also provide services linked to the other GNSS systems - GPS, GLONASS as well as EGNOS.

The services will comprise on the one hand, recent and past GNSS function and performance monitoring and on the other hand prediction capability about the near future situation in GNSS services. Today there are already several such services offered for GPS from different sources. The GalTeC philosophy is understood as a single source for such bundled GNSS information provision but with main focus on Galileo.

Such that the GalTeC can be found logically between the Galileo Systems (plus other GNSS) and the End User on one hand, also between Galileo System and downstream Commercial Service provider on the other hand. The latter can also be SAR service providers as well as Galileo Regional Integrity providers. For example the Regional Integrity providers would need to assess which Galileo satellites over the Region can transmit the data with which elevations for which time frame.

GalTeC architecture

The GalTeC architecture will basically consist of a scalable server/client architecture with several computer systems on

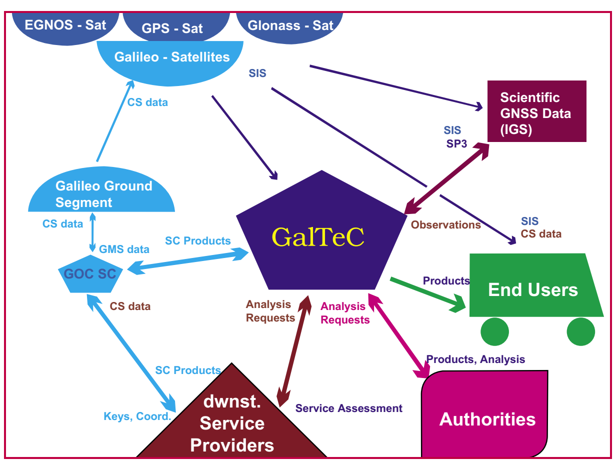


Figure 1: GalTeC Context

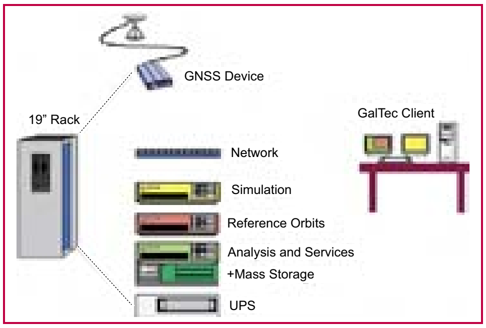


Figure 2: GalTeC Components

which the different software-based functions will be realised.

The basic HW mounted in a single 19' rack consists of the three GalTeC servers with integrated mass storage. The various analysis and evaluation software on the GalTeC servers need access to the Internet in order to download actual data from various sources delivering GNSS measurement and evaluated data. The external access to GalTeC is given through the dedicated GalTeC Internet Server. For security reasons the GalTeC Internet services are actually not provided by the GalTeC main server itself.

The GalTeC will be connected internally to local users with own working stations for performing individual computations. There will also be one workstation direct at the location of the server. Finally it is planned to foresee a connection to the Galileo Ground Segment via its Service Centre Interface, or to a dedicated Central Galileo Service Centre. Also GalTeC is planned to finally act as one of the first Galileo Service Centres.

Figure 3: GalTeC main hardware

GalTeC will provide the following features:

Measurement:

- Monitoring Galileo and other GNSS system performance from independent user stations
- Interface to international GNSS service like IGS to exchange data and information Reference Orbit & Satellite-Clock Determination
- Provision of highly precise satellite ephemeris (orbit and clock parameters) – for a posterior assessment of GNSS system performance
- Independent SIS performance evaluation service covering the past and current system status of Galileo, SBAS, GPS, GLONASS
- Trouble shooting in system and user domains
- Performance analysis and verification in user domain (GNSS receiver, air traffic and marine traffic applications etc.)

Prediction and Service Volume Simulation

- Performance prediction using a service volume simulation tool based on ephemeris or almanacs
- Consultancy for commercial service providers for their access to the system, dimensioning of their service and prediction of the service performance

Analysis and Products

- Independent calibration of the major Galileo/GNSS system parameters (satellite force models, satellite clock models, propagation models, processing models etc.)
- Provision of the GalTeC products, precise orbit, clock, Galileo/GNSS ephemeris, PVT and Integrity monitoring results

Measurements	Simulation	Referencing	Analysis
Collect: - GNSS receiver raw data - GNSS receiver processed data from - IGS and other network sources - GalTec (mobile) receiver(s)	- Service Volume Simulation (as basis) - Substitution of missing Galileo real data - Extrapolation of single-point results to service area - value added services Dimensioning (CS, SOL, ERIS, SAR)	- Reference High Precision Orbit & Clock data generation (post processing) - Prediction of orbits - Orbit and ranging quality factors (SISRE, etc.)	- Statistical Analysis - Formal reports generation - Routine services (GNSS status reports, etc.) - Customer specific analysis - Interfacing with Galileo (Master) SC

Table 1: GalTeC Basic Functions

The development of the related Software packages are performed jointly by Thales and NavPos systems, where the latter is fully responsible for the Simulation (or Prediction) package.

The GNSS measurements are used to generate high precision reference data, i.e. Precise Satellite Orbits and Clocks in SP3 format. These are then used to determine Orbit and Clock errors on the basis of GNSS broadcast ephemeris.

In parallel the Simulation or Prediction tool uses the collected original broadcast ephemeris and almanac to compute out of the satellite geometry the PVT quality factors for a time and area window. To choose the correct model - input parameters are needed out of the analysis in a back loop for e.g. a single position (that of the reference station). The Analysis functions will then analyse the computed results from the Reference

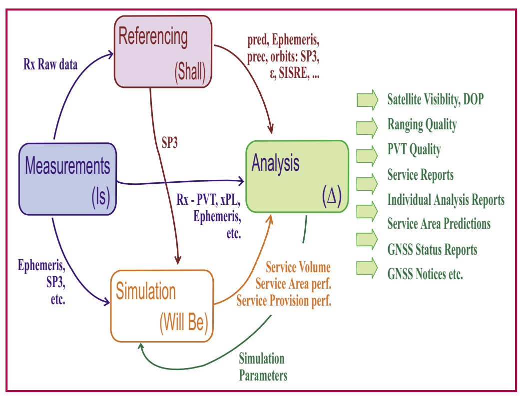


Figure 4: Interaction of GalTeC main Functions

module and present the analysis results in a more visual way (e.g. a classical trade-off: Is vs. Shall vs. Prediction). Then the services functions will be used to generate then the different reports with integrated graphics and final results in usual formats (ASCII, XML, PDF,...). Figure 4 shows the interaction of the main GalTeC modules.

Reference OD&TS

The reference orbit determination and time synchronisation (OD&TS) is a very important component for GalTeC. It provides the precise reference orbit for further data analysis and processing.

The reference orbit determination is performed in GalTeC using raw measurements from GSS stations and monitoring station networks like IGS (International GNSS Service). Also GalTeC own ground stations will collect pseudo-range and carrier phase

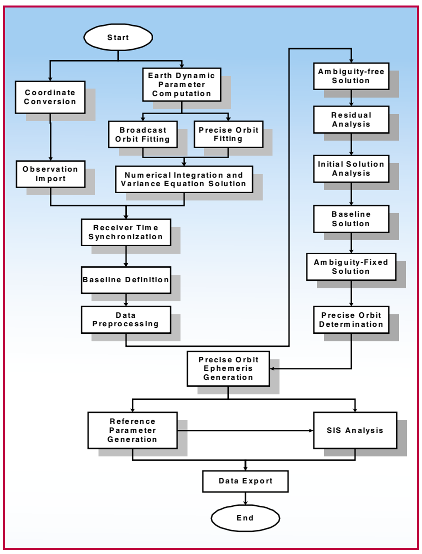


Figure 5: Processing Steps of Reference Orbit Determination

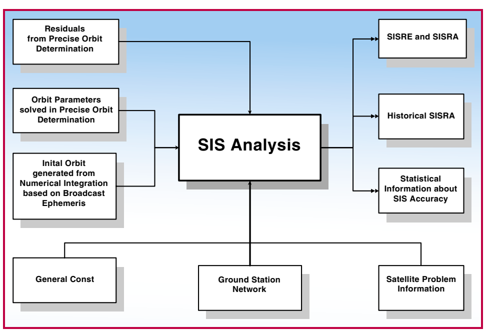


Figure 6: Signal-In-Space Analysis

measurements and provide them offline to GalTeC for further data processing.

The major processing steps of reference orbit determination can be illustrated as in figure 5 and 6.

The Galileo or generally GNSS satellite orbits are determined using the dynamic method in batch processing mode. Assuming the satellite movement equation is

$$\ddot{\bar{x}} = -\mu \frac{\bar{x}}{|\bar{x}|^3} + \frac{\partial R}{\partial \bar{x}} = f(\bar{x}, t) \qquad \text{(Eq. 1)}$$

where,

$\ddot{\bar{x}}$ satellite acceleration vector,

$\bar{x}$ satellite position vector,

μ earth's gravitational constant,

R sum of various perturbation sources, i.e. $R = R_e + R_s + R_m + R_l + R_\Sigma$.

R_e geopotential model,

R_s, R_m solar and lunar attraction models,

R_l solar radiation pressure model,

R_Σ other small perturbation models

Then the batch processing mode can be expressed as

$$\bar{x}_k = \Phi_{k,k-1}\bar{x}_{k-1} + \Gamma_{k,k-1}\bar{w}_{k-1} \qquad \text{(Eq. 2)}$$

with the observation equation

$$\bar{y}_k = H_k \bar{x}_k + \bar{\varepsilon}_k \qquad \text{(Eq. 3)}$$

where

$\bar{x}_k$ n dimensional satellite orbit and dynamic parameters,

$\bar{y}_k$ m dimensional observation vector,

$\Phi_{k,k-1}$ $n \times n$ dimensional state transition matrix,

$\bar{w}_k$ dynamic system noise vector,

$\bar{\varepsilon}_k$ observation noise vector,

$\Gamma_{k,k-1}$ coefficient matrix of dynamic system noise vector,

H_k $m \times n$ dimensional observation coefficient matrix

The equations above can be solved together with numerical integration, i.e.

$$\left.\begin{aligned} \bar{x}_k &= f(\bar{x}_k, t) \\ P_k^- &= \Phi_{k,k-1} P_{k-1} \Phi_{k,k-1}^T + \Gamma_{k,k-1} Q_k \Gamma_{k,k-1}^T \\ K_k &= P_k^- H_k^T (H_k P_k^- H_k^T + R_k)^{-1} \\ \hat{x}_k &= \bar{x}_k + K_k (y_k - H_k \bar{x}_k) \\ P_k &= (I - K_k H_k) P_k^- \end{aligned}\right] \qquad \text{(Eq. 4)}$$

where P_k is the weight matrix of parameters.

GalTeC can compute the so-called SISE (Signal-in-Space Errors) as follows

$$SISE = R_{srew,k}(\bar{y}_k - H_k \hat{\bar{x}}_k) \qquad \text{(Eq. 5)}$$

where $R_{srew,k}$ is the conversion matrix to the worst user location. But this SISE reflects only the performance of the reference orbit determined by GalTeC.

Assuming $\bar{x}_k^E$ computed from Galileo broadcast ephemeris, SISRE (Signal-In-Space Reference Errors) can be computed by

$$SISRE = H_{srew,k}(\hat{\bar{x}}_k - \bar{x}_k^E) \qquad \text{(Eq. 6)}$$

where, $H_{srew,k}$ is the mapping matrix to observation domain at the direction to the worst user location. The SISRE reflects the actual accuracy of Galileo broadcast ephemeris.

SISRE is a key performance parameter which can be used for monitoring and validation of the performance of the Galileo broadcast orbit.

Based on SISRE, another key performance parameter, SISRA\ (Signal-in-Space Reference Accuracy) can also be computed. SISRA is a minimum standard deviation of the unbiased Gaussian distribution over-bounding SISRE. SISRA can be directly compared with Galileo broadcast SISA and SISMA.

Service Level Prediction

For the prediction of the system performance and also for the design and dimensioning of the GNSS Services a simulation function is needed. For this purpose, the NavPos Systems Service Volume Simulator AVIGA® will be used and further developed to a GalTeC Prediction tool in the frame of the GalTeC project. The prediction tool offers the means to predict, analyse and evaluate Galileo Services.

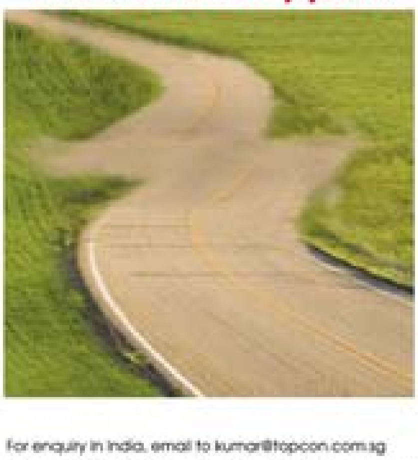
A main AVIGA Objective shall be the analysis of the GNSS performance at the user using simulation data. AVIGA offers to run the simulation analysis at point, over area and along routes in terms of

- Accuracy,
- Continuity of Service,
- Integrity and
- Availability.

Ensure that your project is accurately measured for a smooth journey

Insist on using Topcon precision surveying instrument

This will not happen!



TOPCON Pulse Total Station

Superior features to change your field work dramatically

More precise
Topcon's pulse-laser technology "time-of-flight" system eliminates measuring errors caused by the overlapping signals used in phase measuring systems.

Easy to use
Operation with alphanumeric keyboard and touch panel to make easy control and data entry.

Versatile software
On-board software applications contain 'Road' function that boost your productivity.

Safety
Distance measurement with Laser Class I is safe to use around populated areas.

For enquiry in India, email to kumar@topcon.com.sg

Topcon South Asia Pte Ltd (South East Asia Regional Headquarter)
Block 192 Pandan Loop #07-01 Pantech Industrial Complex Singapore 128381
Tel: (+65) 6778 3456 Email: marketing@topcon.com.sg

www.topcon.com.sg

In addition, AVIGA shall allow to analyse the GNSS constellation performance in terms of

- Visibility and
- Geometry.

AVIGA simulation will be composed of modules, which will fulfil the following tasks:

Space Segment Module: predicts satellites trajectories from standard almanacs, e.g. Almanac YUMA files, computes satellite trajectories from user – defined Keplerian elements; Broadcast Ephemeris or SP3 Precise Ephemeris.
Visibility Module: evaluates visibility characteristics of satellite coverage accounting for mask skyline angles;
DOP (or Geometry) Module: evaluates DOP and Position Error characteristics of satellite coverage, position accuracy is estimated from the position errors covariance matrix.
Availability Module: evaluates availability of DOP and position accuracy. Models of satellite outages and navigation solution errors are used in this model. Integrity/Continuity Module consists of sub modules which can be also considered as independent modules:
RAIM: evaluates availability of the snapshot RAIM FD/FDE methods.
SBAS: evaluates availability of the SBAS Protection Levels.
Galileo: evaluates availability of protection level according to concept proposed for Galileo system, calculates the pertaining Integrity Risk.
Availability of Integrity Risk: analyses availability of Integrity Risk according to concept proposed for Galileo system
GBAS/Galileo LE: analyses performance of GPS, Galileo based LAAS systems
Route Module: analyses performance along a specified route
SISE Analysis Module: assesses satellite orbital and clock errors from SP3 and RINEX Navigation files.

Further modules which will be implemented or extended as part of GalTeC Phase II

Data Dissemination Module: simulates disseminating of Galileo Messages from Ground Mission Segment via ULS network to world-wide or regional users.
End-to-End Service Volume Simulation: This module will allow error components simulation on Galileo element level to analyse the Galileo Service performance and the impact of various errors sources.

The prediction of the Galileo Services according to their specification, and also with further parameter settings, shall be done with the GalTeC Prediction Tool. The tool shall also allow the simulation of seldom failures of the system such as erroneous behaviour and outages.

Figure 7 and Figure 8 show examples of the GNSS Services Accuracy Performance prediction for the GPS SPS and the Galileo OS.

A further very important parameter for the performance assessment of the Galileo Safety of Life Service is the Signal in Space Error (SISE). For the provision of Galileo integrity, the main role is assigned to the integrity flags which are generated in the Integrity Processing Facility.

The generation of integrity flags is based on the determination of SISE in real time. The value of SISE depends on the number of ground sensor stations (GSS) and the satellite to GSS errors. A further means to determine and evaluate the SISE performance is done in post-processing. Figure 9 shows the difference between the GPS/SP3 reference orbit and the Broadcast Ephemeris data which were broadcast in real-time.

The Prediction Tool shall be used for the dimensioning of services and for the performance assessment in relation to the needed signal bandwidth. The signal bandwidth will probably play an important role in the service transmission cost estimation. The design and dimensioning is needed for the feasibility and cost estimation of a service. An application example for GalTeC will be to offer Service Providers the possibility to check needed data volume and distribution strategies for their planed Services.

The GalTeC Service Volume Simulation and Level Prediction Tool offers the means to predict, analyse and evaluate Galileo Services.

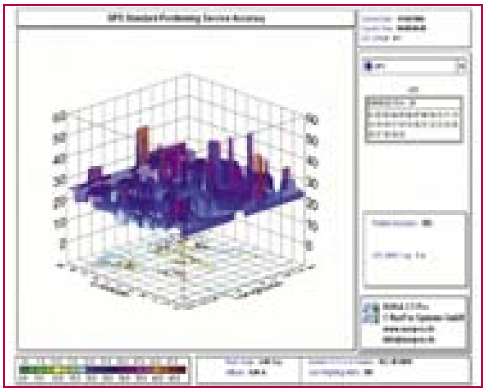


Figure 7: GPS Standard Positioning Service Accuracy

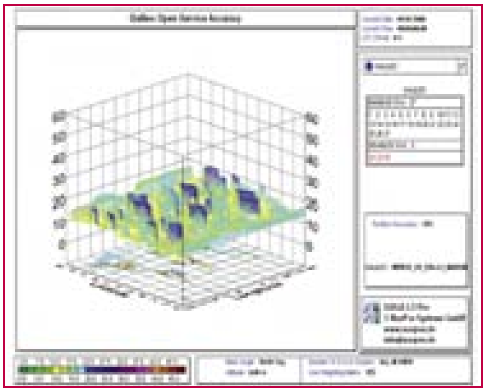


Figure 8: Galileo Open Positioning Service Accuracy

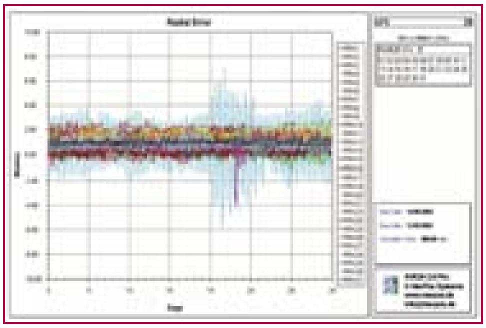


Figure 9: Analysis of the SISE/Orbit Accuracy as difference of GPS SP3 – GPS Broadcast Ephemeris

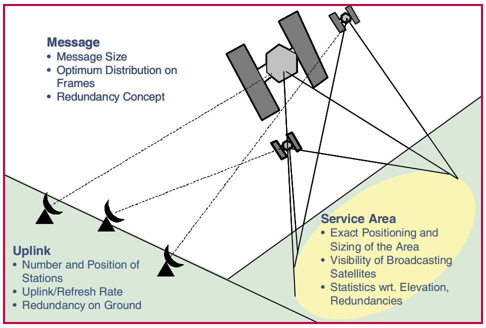


Figure 10: GNSS new Services Dimensioning for GALILEO

Services and Analysis

The data analysis will be composed of various processing modules and used for performance analysis in system

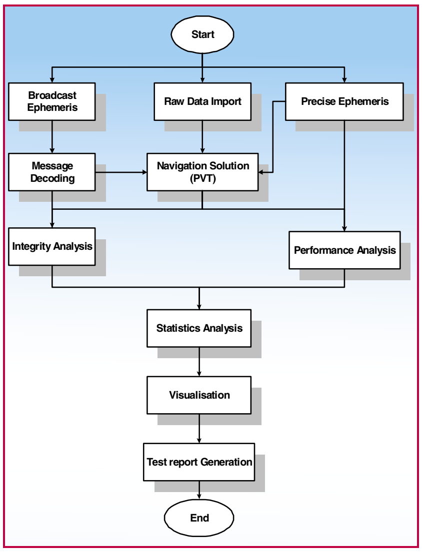


Figure 11: Data Analysis Functions

domain and user domain based on the raw measurements from monitoring station networks and precise ephemeris generated by GalTeC OD&TS.

The main purposes of data analysis are

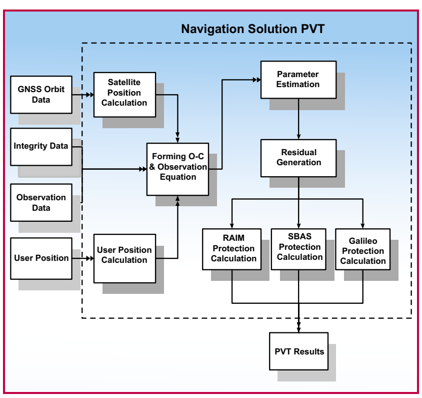


Figure 12: Navigation Solution

- perform navigation solution using raw measurements and broadcast ephemeris
- computation of various protection levels based on RAIM, SBAS and Galileo Integrity algorithms
- generation of various corrections and indicators based on the reference orbit determination to check the performance of GNSS systems
- check and validate the performance in system domain and user domain
- visualization of the analysis results

The function and data stream are shown in the Figure 11, Figure 12, Figure 13 and Figure 14.

At the beginning a twofold PVT (Position/Velocity/Time) solution is executed using in both cases the raw range measurements and then separately using broadcast ephemeris and precise orbits in the other case. This results in a nominal PVT and precise PVT solution which can be compared.

The Integrity Analysis will be performed based on different integrity concepts and algorithms for Galileo, SBAS and GPS (RAIM) systems. Integrity bounds (HPL/VPL) on navigation measurement errors are produced in the module PVT. These bounds together with the residuals generated from PVT are used to determine the confidence levels and related pass/fail criteria.

The Performance Analysis will be used to process and analyse the measurements based on GNSS ephemeris for the navigation, receiver and SIS accuracy, focused on the following error analysis: satellite clock errors, satellite orbit errors, ionospheric and tropospheric errors, multipath, interference errors and measurement errors etc..

These Analysis will be complemented by some other Statistical Analysis functions and represented by appropriate Visualisation functions and then be summarised in semiautomatic Report Generation. These formalised reports are the basis for the offered regular GalTeC services.

Initial Test Example With GPS

Based on the description above, an initial test result using GPS measurements is presented. 24-hour measurements (May 18, 2006) from 39 worldwide deployed IGS stations are used. GalTeC OD&TS used these measurements to generate precise GPS ephemeris called reference orbits with about 18 centimetre accuracy compared with IGS precise ephemeris.

The reference orbits will then be used to analyse performance of GPS broadcast ephemeris and generate related key performance parameters such as SISRE and SISRA. The maximum URA (User Range Accuracy)

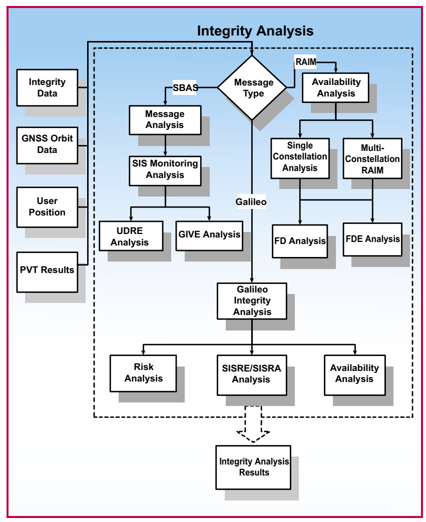


Figure 13: Integrity Analysis

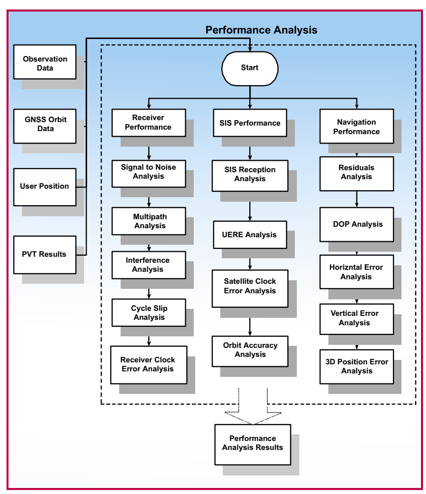


Figure 14: Performance Analysis

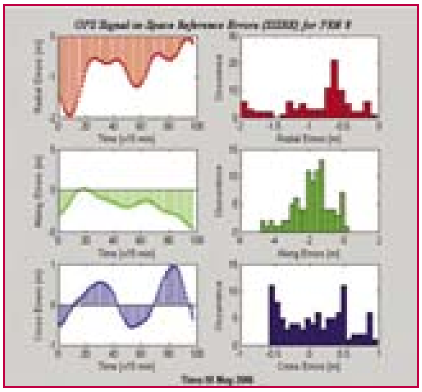


Figure 15: SISRE in Orbit Domain

for one GPS satellite for one day from GPS broadcast ephemeris is used in place of SISA. The plots in Figure 15 show the SISRE in satellite orbit domain, clock domain (Figure 16) and observation domain (Figure 17). The satellite clock performance is presented for comparison purpose.

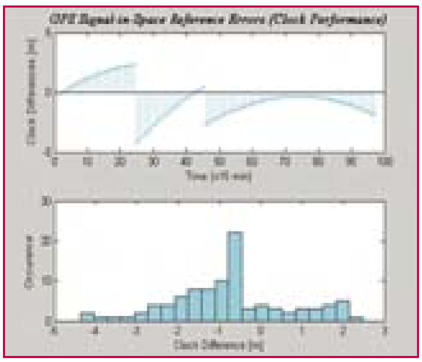


Figure 16: SISRE in Clock Domain

Representatively, the initial results only for PRN 8 are shown here.

The plots show that URA from GPS broadcast ephemeris almost over-bound the actual SISRE in the observation domain with some exception which may be caused by satellite clock jumps or jumps of

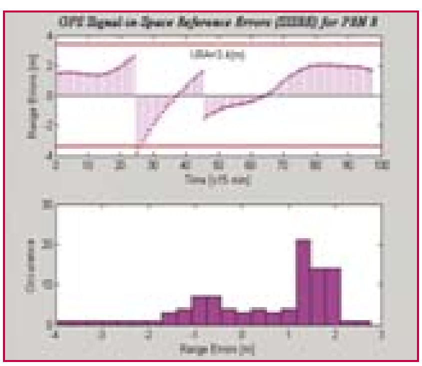


Figure 17: SISRE in Observation Domain

the satellite clock corrections. The further analysis on the test results will be prepared in a separated paper.

Conclusion and Further Work

GalTeC in its final stage will offer functions which might be expected from a Galileo Service Centre. One of the main capabilities will be the independent validation of Galileo performance and of special interest the global and regional integrity performance. However it will be a prototype to gain experience on the way towards a fully fledged and liable Galileo- or generally GNSS-Service Centre.

The first prototype phase of GalTeC has been almost concluded delivering a GalTeC version 1. The GalTeC is introduced to the public already in the prototyping phase to receive first feedbacks already in the design phase as consequently services shall be developed which are considered as useful for various users.

The second phase starting in January 2007 will deliver a GalTeC Version 2 in late 2008, just short before Galileo launches its 4 IOV satellites. The first version is dedicated to the development of the Reference Orbit & Clock software using GPS data for input, developing the Simulation capabilities and first Analysis and Visualisation functions. The main work will however be done with the Version 2 development where the Specifications are reviewed and adapted to the latest information available from Galileo (i.e. full Signal and Services ICDs, Mission Requirements etc.) and the (central) Galileo Service Centre.

Open questions today are the availability of Galileo Signal (Giove-A and -B) within the project run time and related measurements from several sources. Also open is the availability of the Central Service Centre specification and exchange conditions for information. It is expected that the GJU and shortly the GSA will make information available. Some limited access is given to the Thales team through participation in the Galileo development and particularly GMS verification programme, such that by end of 2008 a valuable and powerful tool will be available for experimentation. The capabilities will be demonstrated in the Galileo IOV phase.

Acknowledgments

The authors and project members want to express their gratitude towards the DLR/Bonn for the support of the project.

References

1. Luis Ruiz, GJU, Galileo Overall Programme Status, Plenary Presentation ION GNSS 2005, Long Beach, Sept. 2005.
2. B. kl. Schlarmann et.al., ESA, GMV, The Processing Facilities of the Galileo Ground Segment (GMS), ENC- 2005, Munich, July 2005.

Dr H Su
Air Systems Division, Thales Inc.
hua.su@thalesatm.com

W Ehret
Air Systems Division, Thales Inc.
walter.ehret@thalesatm.com

Dr H Blomenhofer
Air Systems Division, Thales Inc.
helmut.blomenhofer@thalesatm.com

E Blomenhofer
NavPos Systems GmbH
eduarda@navpos.de

KOLIDA

Now Here with You!

Looking for Distributors

KOLIDA is now looking for international dealers and ready to deliver high cost-performance instruments and accessories to users worldwide. Should you have any enquiries, please feel free to contact us. Our latest Products Catalogue and Price List will be soon available for your kind reference.

GUANGDONG KOLIDA INSTRUMENT CO., LTD.

Add: 3/F, Hai Wang Building, Tian He Industrial Park,
Ke Yun Road, Guangzhou 510665, China
Tel: +86-20-85542075 Fax: +86-20-85542136
Mobile: +86-13392122697
Website: www.kolidainstrument.com
E-mail: export@kolidainstrument.com
export@kolida.com.cn

Sales contract from Cessna Aircraft Company to Leica

The Metrology Division of Leica Geosystems, Switzerland announced USA based Cessna Aircraft Company, a Textron company, has signed a sales contract for eight portable Leica Geosystems CMM systems used for industrial measurement and inspection. The acquisition consists of four Leica LTD840 Laser Trackers, and four Leica LTD640 Laser Trackers. Cessna is a manufacturer of general aviation airplanes. Leica Geosystems' 3D coordinate measurement systems are used by manufacturers worldwide in the aerospace, automotive and shipbuilding industries. *www.leica-geosystems.com*

Philips backtracked plan for GPS devices

Philips Electronics, Netherlands has backtracked on its previously stated plan to enter the satellite navigation market. In June the company spread the word about a new line of portable products that it planned for September. After the announcement, shares in TomTom International, the market leader in navigation devices, sunk 3 percent within the hour. But now Philips said it was no longer interested in selling the devices. Spokeswoman Nanda Huizinga said the company kept a close eye on the market in the past few months and decided it was too crowded. "It's a very competitive market and it puts a lot of pressure on profit margins," she said. "We decided we need some focus, and navigation devices like these don't fit within this focus."

The company remains interested in GPS in general, but not for stand-alone products. "We don't want to go further with GPS as a single device, but it's an interesting technology to implement in other products," Huizinga said. Mobile phones or digital music players are possible candidates for GPS capabilities, she said. *www.pcadvisor.co.uk*

ER Mapper licenses GeoCalc

Blue Marble Geographics has announced that ER Mapper recently licensed the GeoCalc 6.3 C++ software developer toolkit to enhance and greatly expand their coordinate system definition and conversion support. Blue Marble's coordinate conversion technology is used worldwide by thousands of GIS analysts at software companies, universities, oil and gas companies, civil engineering, surveying, technology, enterprise GIS groups, government and military organizations. *www.bluemarblegeo.com*

u-blox announces miniature GPS module

u-blox AG, Switzerland launched the NEO-4S GPS module which packs high sensitivity, low power consumption and a USB port into a miniature 12.2 x 16 mm package. The module's -156 dBm SuperSense tracking sensitivity extends positioning coverage to deep indoor locations and enables solutions that use smaller or covert antennas. The absence of a costly Flash EPROM and the ATR0635 single chip that powers the module, developed jointly by u-blox and Atmel, keeps the module's footprint small and the price tag down. Its low power needs and built-in power saving modes ensures power usage is kept at a bare minimum. *www.u-blox.com*

PCI Geomatics signs MoU with LIESMARS

PCI Geomatics has announced the signing of a Memorandum of Understanding (MoU) with the State Key Laboratory of Information in Surveying, Mapping and Remote Sensing (LIESMARS) in China. The MoU outlines plans for cooperation in a variety of areas including the introduction of emerging image-centric geospatial technology in China and outlying regions. It also highlights plans for further promotion of geoinformatics along with a better understanding of the Earth and space. *www.pcigeomatics.com*

Trimble to acquire @Road

Trimble, USA announced that it has entered into a definitive agreement to acquire @Road, Inc. of Fremont, California. @Road, Inc. is a provider of solutions designed to automate the management of mobile resources and to optimise the service delivery process for customers across a variety of industries. The acquisition would enable Trimble to gain leadership in Mobile Resource Management (MRM). *www.trimble.com*

Optech introduces 100 Hz scanning capability

Optech Incorporated announced another technical advance in airborne Lidar mapping: an accelerated scanner rate of 100 Hz. Optech's ALTM Gemini now scans at rates up to 100 Hz. This accelerated scan frequency will directly benefit all surveyors using Optech's ALTM Gemini. *www.optech.ca*

Electric utility to implement Enterprise GIS software

ESRI has announced that it has been selected to provide an Enterprise GIS to ÈEZData, s.r.o. of the Czech Republic, part of the ÈEZ Group, the largest electric utility provider in central Europe. The enterprise site license will enable ÈEZData to deploy the full suite of ESRI's ArcGIS products in an open, scalable, and standards-based GIS architecture throughout the entire ÈEZ Group operation. The GIS will integrate with and leverage existing ÈEZ information technology (IT) resources to meet a broad range of business and engineering needs now and in the future. *www.esri.com*

Lockheed Martin gets $50 million US Air Force deal

The U.S. Air Force has awarded Lockheed Martin, USA a contract valued at approximately $50 million to execute a System Design Review for the next generation Global Positioning System Space Segment program, known as GPS Block III.

GPS III will address the challenging military transformational and civil needs across the globe, including advanced anti-jam capabilities and improved system security, accuracy and reliability. The program will enhance space-based navigation and performance and set a new world standard for positioning and timing services. *www.lockheedmartin.com*

i-Blue 757 solar bluetooth GPS receiver

Manufactured by Transystem of Taiwan, i-Blue 757 is a solar powered bluetooth GPS receiver. Featuring space saving clamshell design., these devices contain the 16 channel Nemerix GPS receiver and also have an embedded rechargeable 1000mAh Li-Ion battery. Without seeing any daylight it should run for about 30 hours, and upto 100 if you can harness the power of the sun.

At the expense of a little consumption of battery power the Bluetooth stack on the i-Blue 757 is kept alive even when no connection is active. As soon as your PocketPC or Smartphone or Notebook establish a Bluetooth connection the 757 will wake up the GPS receiver part, and regain a fix within a few seconds. *www.navigadget.com*

Antrix revenues at Rs 400 crore

ANTRIX Corporation, the commercial wing of Indian Space research Organisation (ISRO) would earn Rs 400 crore this year through Launching satellites for other countries and selling space products. The space agency's commericial arm has roughly abort 25% growth over the last year. "For this year, Antrix's total turnover is roughly about Rs 400 crore.Out of which Rs 200 crore comes from launch vehicle area and remaining from space products, including the transponders we are leasing and the images we are sending," ISRO chairman G Madhavan Nair said here. *economictimes.com*

Google to put NASA data on the Web

Google and NASA have announced the signing of the Space Act Agreement, which calls for them to collaborate on making it easy for people to find weather visualization and forecasting data, see high-resolution 3-D maps of the moon and Mars and track, in real time, the International Space Station and the space shuttle. *www.pcworld.com*

China to launch three satellites

China will be able to keep a closer watch on natural resources and disasters with the launch of six satellites in the next five years, officials said. Half of them will be launched next year and the rest are expected to be in place by 2010, according to sources at a gathering to mark the 15th anniversary of the founding of the China Centre for Resources Satellite Data and Application, which closed in Beijing. *www.chinaview.cn*

New Director of CSSTEAP

George Joseph, an Honorary Professor at the Indian Space Research Organisation, has been appointed Director of the United Nations-affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP). *www.cssteap.org*

ACRES announces reduction in ERS SAR prices

The Australian Centre for Remote Sensing (ACRES) has announced a major price reduction in Synthetic Aperture Radar (SAR) products from the Earth Resource Satellite (ERS). Prices have been reduced from over $2000 down to $590 as a result of ACRES being granted greater pricing flexibility by the satellite operator. The reduced price will increase the attractiveness and utilisation of ERS SAR data to a wide range of users. *www.ga.gov.au*

Korea to develop heat-sensing satellite Arirang 3A

South Korea plans to launch an infrared detection satellite around 2012 that will have both civilian and military applications, according to a state space panel. The satellite, to be called Arirang 3A, will be an upgraded version of the Arirang 3 and will be equipped with a high resolution multi-spectra camera, the newly formed National Space Council said. *english.yonhapnews.co.kr*

Turkey to launch imaging satellite

The Scientific Research Council of Turkey (TUBITAK) is preparing for the launch of a satellite over Turkey by the year 2008. The Federal State Planning Organization will support the project with $10 million. *www.zaman.com*

Dr Kasturirangan appointed in Pontifical Academy of Sciences

Pope Benedict XVI has appointed Dr K Kasturirangan, Member of Rajya Sabha and Director, National Institute of Advanced Sciences and, former Chairman of Indian Space Research Organisation (ISRO), as an Academician of the Pontifical Academy of Sciences. *www.isro.org*

BSNL Cellone launches pilot project in Andhra Pradesh

The BSNL cellone has taken up a pilot project in Andhra Pradesh, India to develop location-based services for cellone subscribers. A gamut of services like Industry "Where Am I" information by various industry services will be provided. Once successful, the services will be introduced in entire South India, said J V Reddy, General Manager, Cellone services, A P Telecom. *www.hindu.com*

ePosition unifies location-based information

A new service that aims to consolidate diverse location-based information will start in 2007. Dubbed ePosition, the service automatically searches points of interest (POI) database and different Web servers for information concerning any place worldwide and unifies the content into a single display. Developed by Korean venture firm GG21 (Global Generation 21), ePosition's pilot-test service will start from January to June next year, while the actual commercial service will commence from July. *www.zdnetasia.com*

Fujitsu unveils GPS receiver with integrated RFID tag

Fujitsu has unveiled a GPS unit with built-in RFID capabilities to provide the best of both worlds. The Tag Locator V2 sports the locating abilities promising accurate longitude / latitude measurements between "three and five meters, and bundles in an active RFID tag that operates on the 429MHz frequency band. *www.engadget.com*

Epson shipping GPS module for mobile phones

Seiko Epson Corporation ("Epson"), Japan has developed an ultra-sensitive, ultra-compact GPS module to meet high demand from manufacturers of mobile phones and other handsets with GPS functionality. Volume shipment of the S4E19863 series has already begun. This product has been used for some time in all GPS-capable models of FOMA903i series1 phones released by NTT DoCoMo, Inc., contributing to the company's services using GPS. *www.epson.co.jp*

MapmyIndia.com launches v-2007

MapmyIndia.com, online maps portal for India, unveiled v-2007. MapmyIndia v-2007 exploits the Web 2.0 platform to introduce a number of features, not yet offered in India. MapmyIndia v-2007 allows users to drag the maps (at all zoom levels) to explore adjoining areas not currently on the screen. *http://db.mapmyindia.com*

deCarta introduces software developer kit

deCarta (formerly Telcontar), USA has announced the launch of the deCarta Navigation Software Developer Kit (SDK). The new developer kit enables personal navigation device and smart phone manufacturers to quickly build and bring to market highly customized and differentiated navigation applications. *spatialnews.geocomm.com*

Spirent Communications expands LBS test leadership

Spirent Communications, UK, a provider of performance analysis and service management solutions, announced enhancements to its LBS test platform. The Spirent UMTS Location Test System (ULTS) enables the full range of Assisted GPS (A-GPS) testing needs; technology and chipset development, design verification of GSM and UMTS devices and UMTS terminal certification. *www.spirentcom.com*

RFID fitted throughout Tokyo neighbourhood

A location-based services trial that will see a famous Tokyo neighbourhood blanketed with around 10,000 RFID (radio frequency identification) tags and other beacons got underway. The Tokyo Ubiquitous Network Project seeks to install RFID, infrared and wireless transmitters throughout Tokyo's Ginza area, which is the most famous shopping area in the capital. The tags and transmitters will provide location-related information to people carrying prototype readers developed for the trial, said Ken Sakamura, a professor at The University of Tokyo and the leader of the project. *www.pcadvisor.co.uk*

RFID technology enables drug authentication

IBM, USA announced new technology to give clients the unprecedented ability to securely share and analyse accurate and real-time data generated by sensors like Radio Frequency ID tags, enabling significant consumer and business applications like drug authentication and e-customs. The new technology, WebSphere RFID Information Center, is based on a recently completed EPCglobal standard called EPCIS, which provides a standard way to securely communicate the data created by sensors and RFID tags, and tie it to existing business information and trading partners. *http://www-03.ibm.com*

Genasys announces new GPP location platform

Vodafone Spain and Genasys, headquartered in Madrid, Spain announce that the operator selected the Genasys Positioning Platform (GPP) as their location enabling server (LES) for the administration and delivery of location based services. Key strengths and differentiating factors of GPP include its proven reliability and advanced location management features; features critical to an operator preparing to extend its location based application portfolio. *www.genasys.com*

£2 million printing press for paper maps

Ordnance Survey Director General and Chief Executive Vanessa Lawrence officially pushed the on button of a massive new £2 million printing press at the mapping agency's Southampton head office recently. The six-colour printing press is one of the largest in the country and will be used to produce Ordnance Survey's paper maps, including the 650 different recreational and leisure maps that together cover every corner of Britain. *www.OrdnanceSurvey.co.uk*

Jakarta reviews spatial plan

The Jakarta city Governor Mr Sutiyoso has said that his office would submit a draft of the Jakarta Spatial Plan to the City Council for approval in February. The Jakarta administration began reviewing the Jakarta Spatial Plan, known as the Jakarta 2010 Master plan in 2005. The administration admitted that the revision was due to rising complaints over the poor quality of the city's environment. *www.thejakartapost.com*

Vehicle location system in Sri Lanka

IWS Holdings Group is to commence the vehicle location system driven with GPS based GIS. However, the system is yet to be approved by the Ministry of Defence. The company expects the defence clearance soon. *www.colombopage.com*

Livestock health initiative in Philippines

ESRI announced that ArcGIS software is playing a role in the Philippine government's Environmental Animal Health Management Initiative (EAHMI), launched earlier this year. The initiative will analyze animal disease distribution and environmental conditions, identify risk factors, and develop sustainable environmental animal health management strategies for the Philippines and is essential for cost-efficient disease control and sustainable agricultural development. *www.esri.com*

Early warning system for tsunami in India

India's Union Science and Technology Minister Mr. Kapil Sibal said that the preparations for establishing a world class national early warning system for tsunami were progressing well and that it would be ready in September 2007. Mr Sibal told a Press conference that high-resolution topography of the coastal belt and bathymetry of shallow water had been initiated. The National Remote Sensing Agency was preparing topographic maps for an area of 15,000 sq. km (7,500 line km and two km inland from the coastline) and so far acquired data for 3,300 sq. km. *www.hindu.com*

CRRI hits the highway with mapping gizmo

Central Road Research Institute (CRRI) has procured India's first road network survey vehicle from Australia. The vehicle, fitted with advanced lasers, cameras and GPS technology, will map data on the condition of roads and collect other roadside information while on the move on highways.

The data would be used by CRRI for conducting analysis on the quality of road infrastructure and traffic flows. The institute will survey 50,000 km of national highways in the first phase. Australian Road Research Board (ARRB) Group, which has been instrumental in introducing the technology in India, has localsised the technology by equipping one Tata Sumo vehicle with the network survey equipment. The survey using the new vehicle is likely to commence in January and the process is expected to be completed for the entire 50,000 km stretch by 2009. Besides, other things the new equipment will allow CRRI to monitor the road network and assess it against other roads as well as assess the suitability and ride quality for road users. *http://economictimes.indiatimes.com/articleshow/739140.cms*

GPS infrastructure network in Southern Poland

Trimble has announced it has supplied its VRS (Virtual Reference Station) software to establish a national GPS infrastructure network in the south of Poland. The VRS network provides a geospatial infrastructure for surveying, engineering and GIS professionals. The network is the first of its kind in Poland and supplies centimeter-level RTK GPS data for a variety of positioning applications including geodetic and cadastral surveying, road and bridge construction, and archeological excavation site location and documentation. There are also plans to use the network for managing and dispatching emergency medical and rescue teams in Krakw to improve efficiency and response times.

The VRS network, known as Malopolski System Pozycjonowania Precyzyjnego, is operated by the BGUM, the survey office of the local government. Built with Trimble GPSNet and RTKNet software, the network covers the southern part of Poland, called Malopolska. In addition to improving the accuracy of results, the network is expected to enable fast measurements within 2-5 seconds. The use of the network will be free of charge for surveyors in the next three years. *www.trimble.com*

Taiwan completes setup of VBS-RTK e-GPS system

Taiwan has finished establishing a real-time kinematic (RTK) system for the nation's e- GPS base stations, catching up with world standards in developing modern positioning and land-measuring technologies, the Land Survey Bureau (LSB) under the Ministry of the Interior announced. According to the bureau, two years ago efforts began to build the system as a means of achieving high-precision results on positioning, as well as for the LSB to offer multi-objective positioning services with added-value applications such as surveys for earthquakes, firefighting and rescue operations. *www.chinapost.com.tw*

GLONASS update

Russia launches trio of navigation satellites

The latest additions to Russia's indigenous satellite navigation system successfully arrived in orbit after a nearly four-hour ride aboard a Proton rocket. Three 3,000-pound satellites were packaged atop the Proton launcher. The delivery was right on target, and the rocket reached the correct orbit about 12,000 miles high with an inclination of around 64.8 degrees. The GLONASS M satellites are designed to operate for up to seven years. *www.spaceflightnow.com*

Russia lifts ban on GPS systems

Russia has lifted a ban on the use of high-definition images made from space and high-precision positioning systems, news agencies reported. The move will allow such systems to be used by businesses and by drivers with GPS navigation. Russian Defence Minister Sergei Ivanov said regulations needed to implement the decision were already in force, the agencies said. "This is what economy-related ministries have been asking for several years," Ivanov told Interfax. *www.themoscowtimes.com*

Russia on joint GLONASS use

Russia is negotiating with other countries on the possible joint use of Russia's global positioning satellite system GLONASS, Anatoly Perminov, the head of the Russian Space Agency said."We are in active talks with India, Kazakhstan, Ukraine and other countries on the joint use of the GLONASS space system," Anatoly Perminov said. "As far as other countries are concerned, we are primarily in talks with the United States and the European Space Agency to prepare agreements on the use of GLONASS jointly with GPS and Galileo [satellite navigation systems]," Perimov said. *en.rian.ru*

MARK YOUR CALENDAR

January 2007

National Technical Meeting "GNSS Benefiting Mankind"
January 22-24, 2007, San Diego, CA
www.ion.org

Recent trends in infrastructure Development – 2007 conference
24 - 25 January 2007
Coimbatore, Tamil Nadu, India
retid2007@gmail.com

February 2007

Integrated Water Resource Management- (IWRM-2007)
5-7 February, Banglore, India
www.angelfire.com/planet/kerf/

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

Current Trends in Remote Sensing and GIS Applications
15-17 February, West Bengal, India
iitkgpconf2007@yahoo.com

3rd Annual GIS Conference and Exhibition
19-21 February, Kuwait
www.gulfgis.com

March 2007

Munich Satellite Navigation Summit 2007
6 - 8 March 2007, Munich, Germany
info@munich-satellite-navigation-summit.org

GEOFORM+ 2007
13-16 March, Moscow, Russia
http://www.geoexpo.ru/defaulteng.stm

3rd Asian Space conference
21-23 March, Singapore
http://pdcc.ntu.edu.sg/ASC2007/

April 2007

63rd Annual Meeting, Featuring New Bio Navigation Workshops
April 23-25, 2007, Cambridge, MA
www.ion.org

GEO-SIBERIA 2007
25-27April, Novosibirsk, Russia
E-mail: nenash@sibfair.ru

May 2007

Spatial Sciences Institute Biennial International Conference
14-18 May, Hobart, Tasmania, Australia
www.ssc2007.com

Intergraph 2007
21-24 May, Nashville, Tennessee, USA
http://www.intergraph2007.com

International Conference on Integrated Navigation System
28-30 May, Saint Petersburg, Russia
elprib-onti@telros.net

Geoinformation for Disaster Management (Gi4DM2007)
23-25 May, Toronto, Canada
junli@ryerson.ca

5th International Symposium on Mobile Mapping Technology
28-31 May, Padova, Italy
naser@geomatics.ucalgary.ca

June 2007

Rivers 2007: 2nd International Conference on Managing Rivers in the 21st Century: Solutions Towards Sustainable River Basins
6-8 June, Kuching, Sarawak, Malaysia
rivers2007@gmail.com.

21st Pacific Science Congress
12-16 June, Okinawa, Japan
psc21@to.jim.u-ryukyu.ac.jp.

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

Geoinformation Forum Japan
20-22 June, Pacifico Yokohama, Japan
geoforum@jsurvey.jp

July 2007

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

August 2007

XXIII ICA International Cartographic Conference
4-10 August, Moscow, Russia
info@icc2007.com.

ISPRS Workshop on Updating Geo-spatial Databases with Imagery
28-29 August, Urumchi, Xinjiang, China
jjie@nsdi.gov.cn, jiangjie_263@263.net.

September 25-28, 2007

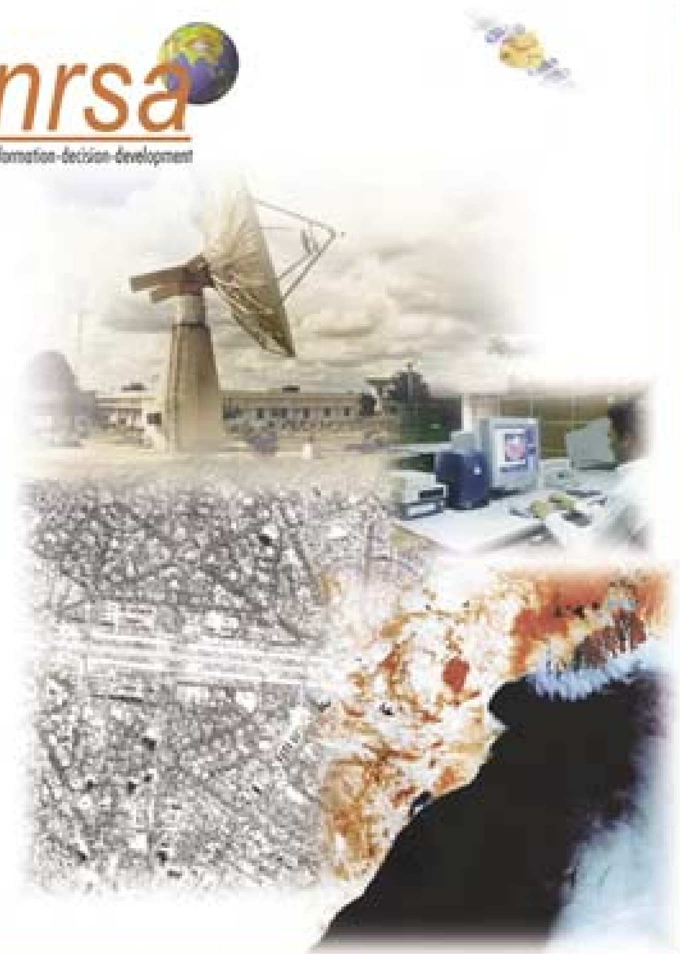
ION GNSS 2007
September 25-28, 2007, Ft. Worth, TX
www.ion.org

November 2007

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

WG I/6 Workshop on Earth Observation Small Satellites for Remote Sensing Applications
13-16 November, Kuala Lumpur, Malaysia
mazlan@fksg.utm.my

nrsa
information-decision-development



YOUR DESTINATION FOR

- Data from both Indian and international satellites for diverse needs
- Aerial services, photography and digital mapping
- Quick, accurate, cost-effective data
- Inputs towards decision support for disaster monitoring and mitigation
- Mapping and management of natural resources
- Immediate updated information on dynamic themes
- Training in Remote Sensing, Geoinformatics and allied fields

OUR THRUST AREAS

- **Applications**
  - Agriculture and soil resources
  - Groundwater, irrigation command, snowmelt
  - Forestry and ecology
  - Land use
  - Oceanography
  - Infrastructure planning
  - Urban Resource Information System
- **Disaster support and environment**
  - Support towards disaster mitigation
  - Environment impact assessment
- **Technology**
  - Deployment of satellite/ground based systems for data reception and processing from Indian satellites anywhere on globe
  - Satellite and aerial data services
- **Capacity building**
  - Training and education

CONTACT US

NRSA Data Centre

National Remote Sensing Agency

Department of Space

Government of India

Balanagar, Hyderabad - 500 037

Phone:+ 91-40-23884423/22/25

Fax: + 91-40-23878158/23878664

Email : sales@nrsa.gov.in

URL: www.nrsa.gov.in

Keep your database up-to-date

Leica MobileMatriX has been developed for seamless dataflow between field and office, and was designed specially for the needs of field surveyors and GIS data collectors. Now it is possible to seamlessly extend the office database into the field, with direct interfaces to Total Stations (TPS) and Global Positioning System (GPS) sensors. All surveyed and collected data is automatically stored into the ESRI® Geodatabase format, eliminating the need for data conversion when moving data between Leica MobileMatriX and ArcGIS™ databases. To update the office database, simply use the synchronization mechanism to transfer the data from office to field and vice-versa. To ensure maximum compatibility with all systems, Leica MobileMatriX allows the user to interact with data from different CAD packages and other GIS office solutions.

Leica Geosystems
Woodlands East Industrial Estate
Singapore 738068
Telephone: +65 6511 6581
Email: isa.support@leica-geosystems.com

www.leica-geosystems.com

- when it has to be **right**