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

No: DL(E)-01/5079/11-13
Licensed to post without pre-payment U(E) 28/2011-13
Rs.100

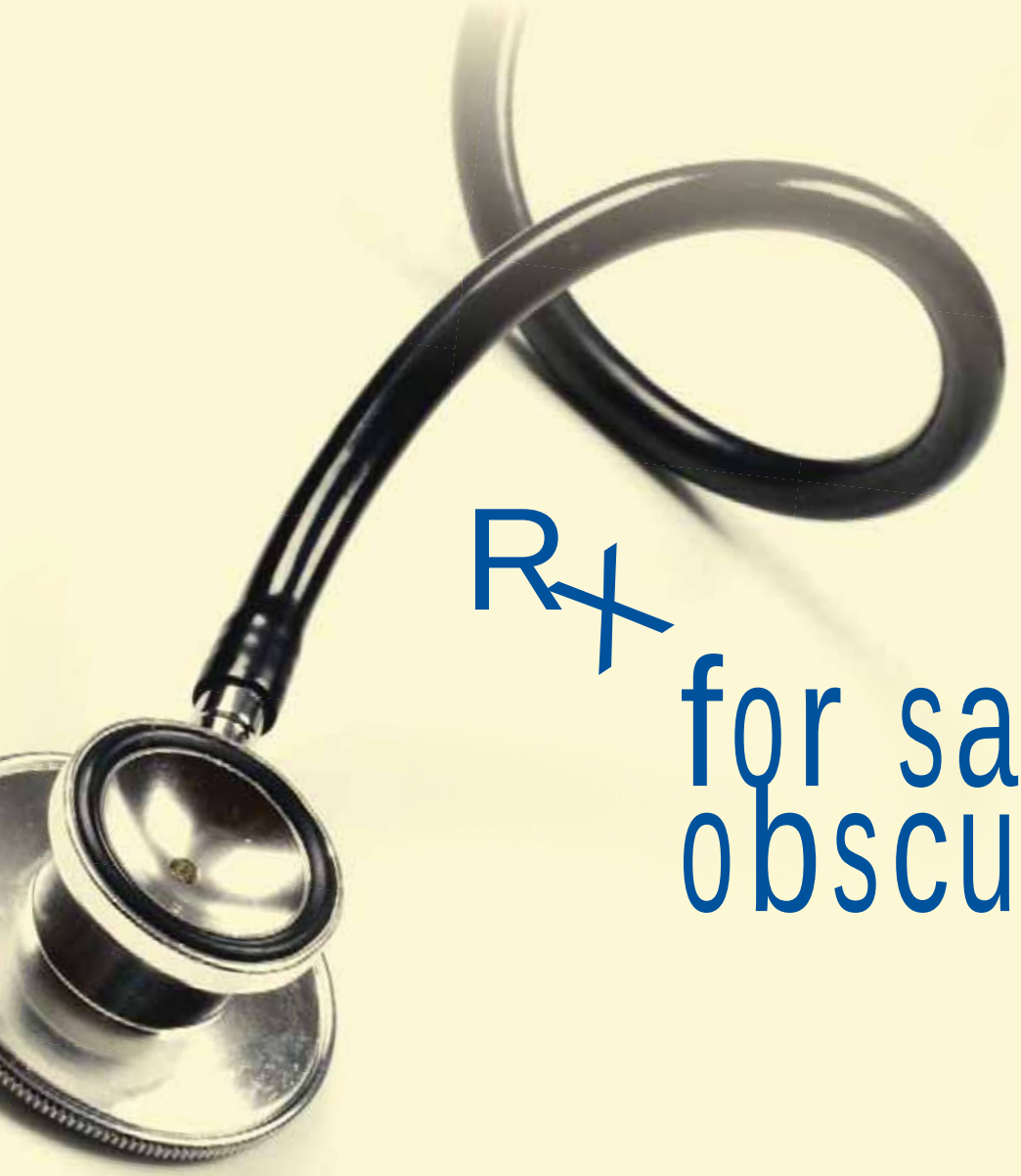
ISSN 0973-2136

www.mycoordinates.org

Coordinates

Volume VIII, Issue 4, April 2012

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND



Rx for satnav obscuration

GAGAN • GEODESY • HYDROGRAPHY

SOUTH
Target your success

South GNSS Family
Grandly Arriving !

India Headquarters
SOUTH PRECISION INSTRUMENT PVT.LTD.
Add: 1108-09-10-11, 11th Floor, RG Trade Tower,Plot No-B-7,
Netaji Subhash Place, Pitam Pura, New Delhi-110034
Tel: +91-11-49995999, 9999999255 Fax: +91-11-45605999
Http://www.southinstrument.com Http://www.southprecision.in

Hyderabad Office
SOUTH PRECISION INSTRUMENT PVT. LTD.
Add: 6-3-90 2/1, 2nd Floor, ESA Arcade
Beside Pratul Honda,
Raj Bhawan Road, Somajiguda,
Hyderabad-500082
Tel: 040-42226269, 040-64618055
Mob: 09891197687, 8886101250

Mumbai Office
SOUTH PRECISION INSTRUMENT PVT. LTD.
Add: A--103, Om Shivam center,
Plot No: A-33+34, Sector-20,
Nerul Rly Station , Nerul (West),
Navi Mumbai-400706
Tel: +91-22-32210052
Mob: 9766329600

Kolkata Office
SOUTH PRECISION INSTRUMENT PVT. LTD.
Add: CD-225, Ground floor, Bidhan Nagar,
Sect-1, Salt Lake City, Kolkata-700064
Tel: +91-33-40621099
Mob: 9681840246, 9007002404

Ahmedabad Office
SOUTH PRECISION INSTRUMENT PVT. LTD.
Add: B/2, Aurobindo Co-operative Society
Near Vastrapur Lake, Bodakadev
Ahmedabad-380054
Mob: 9718636627, 9971207133

Wherever your innovation takes you...

...get there with Trimble Precision GNSS + Inertial solutions for systems integrators

• *Navigation* • *Unmanned Vehicles* • *Machine Control* • *Asset Tracking* • *Mobile Mapping*

Trimble®

www.trimble.com/gnss-inertial

In this issue

Coordinates Volume 8, Issue 4, April 2012

Articles

Columns

This issue has been made possible by the support and good wishes of the following individuals and companies
Agustín Molina García, César García Aranda, Driss El Azzab, Elango K, El Hassan El Brirchi, Heike Haas, James L Farrell, K N Suryanarayana Rao, K Sampath Kumar, Mohamed Eleiche, P Soma, S V Kibe; and Ashtech, CHC, Foif, Geneq, Hemisphere GPS, Javad, HiTarget, Kanq Digital, Kolida, MicroSurvey, Pentax, Navcom, NovAtel, Racelogic, Riegl, Spectra Precision, South, Techequip, TraceMe, Trimble and many others.

Mailing Address
50 A Pocket A
SFS Mayur Vihar Phase III
Delhi 110 096, India.
Phones +91 11 22632607, 98102 33422, 98107 24567
Fax +91 11 22632607

Email
[information] talktous@mycoordinates.org
[editorial] bal@mycoordinates.org
[advertising] sam@mycoordinates.org
[subscriptions] iwant@mycoordinates.org

Web www.mycoordinates.org

Annual subscription (12 issues) [India] Rs.1,200
[Overseas] US$80

Printed and published by Sanjay Malaviya on behalf of Centre for Geoinformation Technologies at A221 Mangal Apartments, Vasundhara Enclave, Delhi 110096, India.

Editor Bal Krishna

Owner Centre for Geoinformation Technologies

Designed at Spring Design (springdesign@live.com)

Printer Thomson Press India Ltd., B 315, Okhla Phase I, New Delhi - 110020, India

This issue of Coordinates is of 60 pages, including cover.

Mission Possible: Survey Where Others Can't

ProFlex™ 800 | powered by ashtech

GNSS receivers are great. Until your boss asks you to work somewhere like this.

Innovative Z-Blade technology aggregates and optimally processes signals from multiple GNSS constellations to deliver unprecedented efficiency, providing fast and reliable RTK positions in difficult environments such as urban construction sites or beneath tree canopies.

The new Spectra Precision ProFlex 800 receiver - powered by Ashtech - is a powerful positioning solution in an extremely rugged package, designed to withstand harsh environments. Whether used as a survey backpack or machine-mounted, Proflex 800 is your flexible solution for construction site productivity.

ProFlex 800 : designed to maximize the productivity of your mission

Z-BLADE TECHNOLOGY INSIDE

Features

- Z-Blade GNSS centric technology
- Fast and reliable RTK fix
- Ultra rugged and waterproof design
- Built-in communication features
- Versatile solution

Spectra Precision Division
10355 Westmoor Drive,
Suite #100
Westminster, CO 80021, USA
www.spectraprecision.com

Ashtech S.A.S.
Rue Thomas Edison
ZAC de la Fleuriaye, BP 60433
44474 Carquefou Cedex, FRANCE
www.ashtech.com

SPECTRA PRECISION

Privacy 'Rights'

The recent ruling of US Supreme Court

Which has termed placing GPS tracker without a warrant as illegal

Has prompted The US Federal Bureau of Investigation (FBI)

To turn off about 3,000 tracking devices.

And again re-stirred the debate on privacy.

In an era when technology tends to encroach

In domains, deemed otherwise 'personal and private'

Like tracking real-time movements, road uses, navigation,…

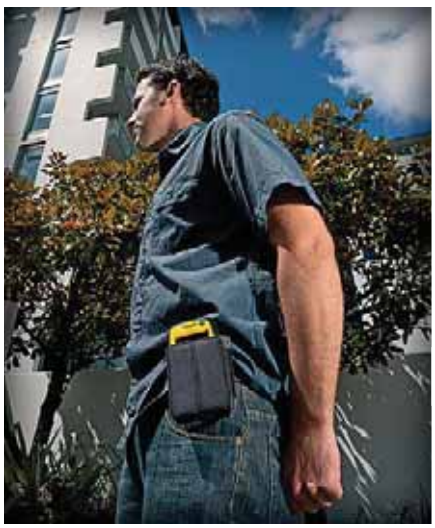
The insistence on 'privacy' will end up

In a battle,

That is likely to be lost.

Bal Krishna, Editor
bal@mycoordinates.org

Your most valuable assets walk in and out the door every day. Send your GIS with them.



THE NEW TRIMBLE JUNO

IT NO LONGER TAKES A GIS EXPERT TO ADD EXPERTISE TO YOUR GIS

They may not be GIS experts, but with the new Trimble® Juno® handhelds, your mobile workforce is your secret to multiplying GIS field expertise across your organisation.

This rugged compact device replaces paper notes and sketches from various departments with GPS data and geotagged digital images in real time—improve the scope and accuracy of your GIS with every report.

Simple and reliable, straight from the box, the new Juno handheld is the latest innovation from Trimble to help you get more out of the field and into your GIS than ever before.

For product demo and pricing see your Trimble distributor or visit: Trimble.com/juno

Trimble®

Rx For Satnav Obscuration

James L Farrell
Vigil, Inc.,
Severna Park,
Maryland, USA

It is increasingly clear that our industry has an opportunity to pool our information from multiple sources and mitigate the current high level of risk. Let's just do it.

Various publications have lately drawn increased attention to the industry's need for more timely adaptation to change. While recent commentary has largely focused, understandably, on spectral issues, it is widely understood that the overall need is multifaceted – i.e., in addition to the highly important spectrum-related investigations already widely circulated, there are further steps that could reduce vulnerability to coverage limitations.. To the existing tracts on the adaptivity theme I wish to offer my own observations. As musings prompted by one individual's limited experience, these reflections cannot by any means represent a complete prescription answering this global question. Nevertheless, significant value can be gained from a response offering meaningful solutions wherever needed. In fact, solutions offered herein are asserted to give performance improvements that are urgently required.

Need for broader receptiveness

Past and current happenings provide instructive insights. PayPal founder Peter Thiel noted that "If Einstein sent a letter to the White House, it would get lost in the mail room and be treated as a joke." I'm no Einstein – far from it – but even from a much lower level, a need for change is easily sensed. For relevance of Mr. Thiel's statement, consider: Einstein wasn't mainstream. To connect that fact with the present, statements below exemplify utterings from three of the best-known people in today's navigation community:

- "... can't see the forest for the trees" (regarding a popular methodology)
- " ... it's amazing how slowly good ideas get adopted!"
- " ... it's like pulling teeth to get a good idea accepted today"

Some resistance to innovation is attributed to an installed base, but upgrading from now through the future does not have to imply a demand for retrofitting. Inertia is another major impediment to acceptance of innovation – people are creatures of habit. A past experience described below illustrates that.

One Saturday night in early January 1981 I was nearly killed. Next to the window at the "Top of the World" restaurant atop the World Trade Center, even the edge of the brick outside was obscured by fog. A foreign airliner, essentially blinded by it, very nearly collided with the building (that time it would have been accidental). Still, without action by an alert air traffic controller, I would have been gone. It occurred to me then: data bases with buildings and all other potential obstructions could easily be compared vs projected flight paths to avert danger. Controlled Flight Into Terrain (CFIT) was already a known concept; why wasn't prevention a routine procedure? After years of talking about this to as many people as possible, I finally stopped. Then in 1996, U.S. Secretary of Commerce Ron Brown was killed as a plane collided with a mountain. CFIT increased in importance and finally became widely recognized. Moral of the story: timely acceptance of existing available solutions could prevent, or at least reduce, tragic happenings.

Inertial augmentation: Perceptions

Wider recognition and increased importance are now being attached to protection against GPS/GNSS vulnerability. Again, much important spectrum work – already documented – needs no repetition here. Instead, attention is now drawn to methods solving other critical problems. One area is GPS/Inertial integration for which a recent list of urgent needs [1] included (among other issues) the following ***perceived*** shortcomings:

- defining models for the inertial sensor errors
- cost

Hemisphere GPS

Search

S320 GNSS Survey Solution

Works Anywhere in the World • **Studied** Geomatics Engineering at the University of Calgary • **From** Calgary, Alberta, Canada • **Born on** September 12, 2011

Post your comments at www.facebook.com/HemisphereGPS

Post

Wall
Photos (1,990)

Friends (2,007)

Carlson SurvCE Software

XF1 Data Collector

Interests Include
Land Surveying, Static Surveying and Construction

Hobbies Include
GNSS, SMS RTK & Texting, L-Band and SureTrack™ Intelligence

Mike McLean
Hey buddy, just finished surveying under some thick canopy. Your accuracy was incredible. Thx!
1 hour ago Like • Comment • Share

Samantha Swanson
I'm glad I can turn you on and off with a text. ;)
3 hours ago Like • Comment • Share

Janet Jones
Wow, long night. LOL. Glad you have more than 8 hrs. battery life!
8 hours ago Like • Comment • Share

Post your thoughts on our wall at www.facebook.com/HemisphereGPS
Your comments could appear in our next print ad!

Contact Info www.S320Surveyor.com • precision@hemispheregps.com

- attitude accuracy
- complexity of use
- availability (or unavailability) of other sensors/systems.

Responding to those perceptions, with sufficient depth despite the necessity for brevity, can be done only by reference to other material. Citing excerpts from my own writings by no means implies that one individual has all the answers (in any case, not all the solutions originated with me), but it facilitates addressing the issues succinctly and from a consistent perspective.

Gyro and accelerometer error models The first item enumerated above often arises from characterization of IMU errors as sets of randomized inputs to various transfer function models (e.g., with positive and negative slopes of different order on plots vs frequency). The concepts are valid but the effects they cover are often overshadowed by a host of motion-sensitive degradations. A "tip-of-the-iceberg" is discussed in [2] while Chapter 4 of [3] plus Addendum 4.B of [4] provide extensive coverage. I'm pursuing it further in an ongoing funded project.

Cost Item #2 is addressed here for systems not needing extended coast capability (which covers a substantial percentage of applications). For that case it is fairly widely accepted that a low-cost system can provide useful performance. Taking full advantage of that, however, requires exploiting methods not at all in the mainstream today. Further elaboration of that fits naturally with the next points.

Attitude accuracy Item #3 is one key reason to go far beyond methods that are almost universal today. In practically all published flight or ground test results (not simulations) with GPS/INS, leveling accuracies are on the order of a few tenths of a degree (and accompanying velocity accuracies do not at all reflect inherent satnav capability). In marked contrast to that, the flight-validated methods documented (with no proprietary strings) in [4] show state-of-the-art RMS leveling accuracies (a few tenths mrad), with cm/sec RMS velocity errors, from roughly an hour of flight (and also from earlier van tests) under severe vibration with low-cost IMUs. A brief description appears in [5].

Complexity of use Item #4 in many cases arises from attempts to "graduate" from loosely coupled to tight or ultratight integration. The latter, and often also the former, involve carrier phase – which many perceive as simple in concept but difficult in practice. Two main reasons for that perception are (1)incomplete understanding of a specific receiver's implementation and (2)intrinsic risk, even with flawless design, of incorrect ambiguity resolution causing catastrophic error. For the first of these, choose only receivers that meticulously form integrated doppler and not approximate deltaranges formed by sampling partial (but not complete) phase history. For the second, usage of 1-sec sequential changes – rather than carrier phases themselves – provides the precise dynamic accuracies just described [5] while eliminating a host of problems (interoperability, acceptance of high intermittency, no masking nor ambiguity). An additional reason for ***perceived*** (not intrinsic) difficulty in usage involves the Kalman filter design itself, specifically the settings for process noise. As with other facets of this topic, there is room for only a short reference here: Section 4.5 of [4]. Also worth noting here – the no-strings documented formulations in [4] contain solutions to "problems" cited elsewhere (including one publication cautioning its readers with over ten "caveats" for carrier phase usage – all of which had successful solutions already flight-verified).

Availability / unavailability of other sensors/systems The last of the enumerated items is a basic integration issue concerned with widening the scope. Notice the reference to "sensors/systems" instead of just sensors. Systems (actually subsystems) give solutions based on subsets of information available to each individual (sub)system. Sensors provide observables that can be combined centrally to produce solutions based on all available information. Ever since day one of Kalman filtering, the best way to extract full information from whatever is available has called for using raw data for all observables. A commonly employed alternative is to combine outputs of "systems" – again, actually subsystems – instantly identifiable with loose coupling approaches. In many cases it works adequately but, as widely acknowledged, it is unprotected from scarcity of data – e.g., incomplete or marginal satellite coverage becomes "loss of satellite navigation." Another major drawback is inflexibility; a turnkey system is convenient until a change is desired (e.g., to accommodate new conditions or measurements to be added). Modification costs then rival the price of the original procurement. Solution: insist on availability of raw measurements and use public domain algorithms to manage them.

Promises, promises – and deliverance

All methods prescribed in discussions that follow are fully consistent with the guideline just stated. Downloadable examples capitalizing on that for satellite navigation with marginal coverage include recent discussions about maintaining operation under adverse conditions, [6] and [7].

For those interested I'll point the way to further information. Depending on how you count, I've attacked vulnerability in multiple areas for some years [8]; a decade [9]; two decades [10,11]; over three decades [12]; – and I'm still at it, e.g., now for collision avoidance [13-16] (with a YouTube link on [13]) – not too soon with unmanned aircraft about to enter the airspace. Much of the vulnerability we face today stems from old habits. Conventional operation hinges on dependable full fixes with RAIM/FDE-supporting geometry. Inescapably that reliance precludes robustness, just as loose coupling precludes both robustness and highly accurate dynamics (and in fact, tight coupling is only the beginning in the list of features needed). Understated in so much present ***and future*** system planning is intermittency due to the severe full range of reasons (jammers, masking, attenuation, IONO/tropo/multipath, vulnerability from weak signals and any other missing link (e.g., communication, etc.) – ***plus*** whatever unforeseeable threats emerge in the future.

Pursue Excellence, Create Quintessence

ONE-STOP

GNSS / GIS SOLUTION

Handheld hRTK System [R2 Series]

KQ High-precise Post-processing Software
KQ Network Adjustment System

KQ BD2/GPS Compatible GNSS Chip

KQ CORS Service System

KQ Realtime Deformation Monitoring System

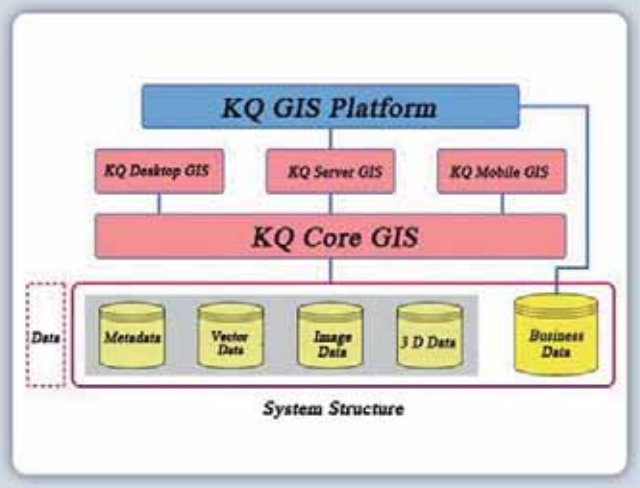
High-performance GNSS Receiver

KQ Realtime Deformation Monitoring System
KQ Realtime Processing System

GIS Data Collector
[K2 Series / V2 Series]

KQ GIS Platform

KQ's five platforms with independent intellectual property right serve a wide range of areas, such as land resources, water conservancy, forestry, agriculture, municipal administration and transportation etc.



System Structure

◄ KQ Mobile GIS Platform

KQ Core GIS Platform ►

KQ Desktop GIS Platform ►

KQ GIS Platform ►

◄ KQ Server GIS Platform

KQ GEO Technologies

Beijing
Address : No.1015-1022,19th Floor, JianDa Building,No.14 dongtucheng Road, Chaoyang District,Beijing, China,100013
Tel : 86-10-85271488 Fax : 86-10-85271489 Web : www.kanq.com.cn
E-mail: marketing@kanq.com.cn maggie.wang@kanq.com.cn

Wuhan
Address : 3/F, Hongye Building, Wuhan University Science Park, University Park Road, East Lake Hi-tech Development Zone, Wuhan, Hubei, China, 430223
Tel : 86-27-59260631 Fax : 86-27-87970886-8018 E-mail : market@kanqdevice.com Web : www.kanqdevice.com

Singapore
Add: 701 Sims Drive
#08-03 Lhk Building
Singapore 387383
Tel: +0065 6299 1776
Fax: +0065 6299 1416
HP: + +0065 90265125
E-mail: plweqy@hotmail.com

Receptiveness – then vs now

Earlier advances (e.g., Differential GPS and conventional usage of carrier phase) were readily and widely accepted but, as the inventory of existing systems has grown, constraining habits have inhibited acceptance of later advances, even as they addressed requisite adaptation to changing conditions such as SA removal, processing advances, new adaptations; e.g.,

- exploitation of sequential changes in ambiguous carrier phase for Dead Reckoning [5]
- extension of DGPS to Relnav with no stationary participant required [9]
- means of accounting for measurement error correlations due to differencing [4]
- operations and interoperability facilitated by single-measurement RAIM [17]
- progress in coordinating surveillance with nav – DME, AGPS, • • •
- innovations via technology advances – three benefits of FFT processing [18] .

Among myriad examples that could illustrate advantages of practices advocated I'll cite one here for SV's either about to vanish or just emerging over the horizon: Recall the insensitivity of 1-sec sequential carrier phase changes to Iono/Tropo effects. No masking is needed; only those observations affected by multipath need be extracted by the single-measurement RAIM just mentioned. The geometry benefit is self-evident. These and many additional issues were discussed at ION-GNSS-11 panel [19] with my presentation documented in ION-GNSS 2011 Proceedings as "Processing of Measurements for Robust Operation under Adverse Conditions." For that presentation I was allowed to borrow from Ohio University designers a short video showing a road test they had made earlier with satellites flickering in and out due to presence of trees. Comparison was made vs a conventional receiver that used correlators and track loops, not FFTs. ***No contest***. The same 1-sec sequential changes in carrier phase that provided 1-cm/sec RMS velocity accuracy in flight with a low cost IMU (and 1-decimeter/sec RMS without it) again were crucial. The brief glimpses that weren't enough to maintain lock in the conventional receiver were fully adequate with the advanced approach using FFTs and 1-sec phase changes.

Numerous other publications could be cited (including a 90-minute tutorial at www.ion.org, free to ION members, plus columns I wrote for InsideGNSS and GPSWorld). Again, those represent one man's experience; other individuals can recall other experiences and cite additional examples illustrating a similar theme: Much of what is "mainstream" is duplication; the industry needs to open up its acceptance of readily available means that are in urgent demand. As the industry moves further toward alternatives to GNSS – using DME, Wide Area Multilateration (WAM), and pseudolites [20] – some of these concepts (e.g., measurements-not-coordinates) offer substantial performance benefits in those approaches as well.

Another kind of availability

As a kid I laughed hard at movie scenes starting with Bob Hope trudging through a desert, desperately uttering "water, water" – and finding himself moments later waist deep in a stream, mumbling "mirage, mirage" – with his desperation undiminished as ever. Parallels between that comic sequence and not-so-funny real life occur repeatedly in multiple areas, including our own. The good news is: solutions are available. Will we accept them? It's in that spirit that I wish to respond positively to current needs.

Originally that last paragraph was intended to close this writing – and then the March 2012 issue of ***Coordinates*** arrived with its excellent cover story. Advocating needed steps (e.g., robustness enhancement, test standardization, • • •), [21] offers

- questions such as "Do we really need to wait for a catastrophe before taking action against GNSS vulnerabilities ?"
- statements such as "It's all solvable. Major portions are already solved."

Amen to all that. It is increasingly clear that our industry has an opportunity to pool our information from multiple sources and mitigate the current high level of risk. Let's just do it.

References

[1] InsideGNSS webinar Feb 29 2012

[2] "Gyro Mounting Misalignment" http://tinyurl.com/JLF-link2

[3] Farrell, J.L., Integrated Aircraft Navigation, Academic Press, 1976 (now in paperback) – http://tinyurl.com/JLF-link3

[4] Farrell, J.L., GNSS Aided Navigation and Tracking: Inertially Augmented or Autonomous, American Literary Press, 2007 – http://tinyurl.com/JLF-link4

[5] "Dead Reckoning by GPS Carrier Phase" http://tinyurl.com/JLF-link5

[6] "Robust Design for GNSS Integration," ION-GNSS-08 http://tinyurl.com/JLF-link6

[7] "Aging SV's – We Have Solutions," ION-GNSS-09 http://tinyurl.com/JLF-link7

[8] "ADSB (2nd-) Best Foot Forward?" Air Traffic Control Journal v50 n3 Summer 2008, pp 17-18

[9] "Send Measurements not Coordinates," ION Journal Autumn 1999 Publ. #66 of http://tinyurl.com/JLF-link9

[10] "That All-Important Interface" (coauthor with Prof. vanGraas, ION-GPS-90)

[11] "System Integration: Performance Doesn't Measure Up" (NAECON 1993 and IEEE-AES Systems Journal) Publ. #55 of http://tinyurl.com/JLF-link9

[12] "Keeping Pace with Avionics Innovations" (NAECON 1977)

[13] Collision Avoidance By Deceleration http://tinyurl.com/JLF-link13

[14] Runway Incursions http://tinyurl.com/JLF-link14

[15] "Simulation Model to Evaluate Collision Avoidance Methods using Raw Measurements in the Automatic

Dependent Surveillance - Broadcast," (coauthor; presented by Maarten UijtdeHaag), ION-GNSS-11

[16] "Unfinished Business: Glaring Absences from the Achievement List," IEEE PLANS-04 http://tinyurl.com/JLF-link16

[17] Single-measurement RAIM http://tinyurl.com/JLF-link17

[18] GPS Receiver Mechanization Pioneered at Ohio University http://tinyurl.com/JLF-link18

[19] http://www.ion.org/meetings/session.cfm?meetingID=34&t=P&s=5

[20] http://www.locatacorp.com/wp-content/uploads/2011/11/FAA-Eldredge-presents-Locata-to-PNT-Advisory-Board-Nov-9-2011.pdf

[21] Dixon, C.S., Hill, C.J., Dumville, M., and Lowe, D., "GNSS Vulnerabilities: Testing the Truth," Coordinates VIII n3, March 2012, pp. 13-20.

FCC action would violate its rights – LightSquared

The FCC's proposal to kill LightSquared's planned LTE network would violate the fledgling carrier's property rights by taking away its spectrum and destroying its multibillion-dollar investment in mobile broadband, LightSquared argues in a formal comment to the agency. Shutting down its project would also violate the public interest by eliminating a potential mobile competitor that would sell network capacity to any carrier, LightSquared said.

Decision regarding LightSquared's network deployment is unfair – JAVAD

For the reasons outlined below I find your recent decision regarding LightSquared's network deployment to be unfair and harmful to not only the U.S. economy, but to the future of innovation. It has been proven time and again that GPS and LightSquared can coexist. I demonstrated this to the PNT earlier this year, and results from independent labs confirmed my results. Even more telling, the recently published recommendations from the NTIA to the FCC do not dispute this fact.

The only real issue is retrofitting faulty GPS units. Let's take into consideration the aviation industry, which is highly regulated and extremely safety conscious. You can subpoena their retrofit histories and see when they found a problem in any parts of their aircrafts and how long it took them to fix the problems. Considering that changing a GPS antenna is easy task compared to other retrofits that they conducted, it will not be surprising to see this retrofit can take in some weeks… *http://javad.com/jgnss/javad/news/pr20120228.html*

Sharing marine data to improve knowledge and coastal management

The study develops a comparative analysis of different sources of marine information that provide data for hydrographic applications, as well as gives a global view of the current availability of them

César García Aranda
Lecturer, Department of Engineering Surveying and Cartography, Technical University of Madrid, Spain

Agustín Molina García
Professor, Department of Engineering Surveying and Cartography, Technical University of Madrid, Spain

In a global context, the lack of information about coastal zones is a crucial issue. These areas are extremely important because of their high productivity in both economic and environmental aspects.

In the European context, the EU has adopted measures that address to improve the marine information (exchange, sharing, access and use of interoperable spatial data and data services).

The Blue Book for Maritime Policy (European Commission, 2007), the Communication "Marine Knowledge 2020" (2010) and the Directive 2007/2/EC of the European Parliament and the Council (INSPIRE Directive) are examples that recognize the importance of establishing an appropriate marine data and information infrastructure.

Currently, the most relevant initiatives in Europe related to providing marine data and information are the GMES initiative (Global Monitoring for Environment and Security), SEIS (Shared Environmental Information System) within its marine environmental component and EMODnet (European Marine Observation and Data Network).

Analysis of technologies for acquisition of bathymetric data

In recent years, the fast advances in technology provide more accurate data and information, tending to error minimization, and allowing the collection of a great quantity of data in less time.

For this reason, a wide range of possibilities about the choice of methods or instruments for bathymetric data acquisition is available. In most cases, the acoustic systems and, in particular, multi-beam systems, are positioned as the main technology to obtain such information. Systems like LIDAR and satellite technologies were not traditionally used for this kind of work because of their limitations. However, in recent years, the technological advancements of these systems have led them to appear as powerful complementary techniques for seabed mapping.

In following sections basics and capabilities of several methods are briefly presented according to the next classification:

- Acoustic methods
- Non-acoustic methods
  - LIDAR systems
  - Satellite systems
    - Data acquisition by active sensors
    - Data acquisition by passive sensors

Acoustic Methods

The acoustic systems for depth measurement are based on the presence of a transmitter (usually working as receptor) that generates an acoustic pulse that travels through the water column. It is reflected off the bottom of the sea and then it is captured by the receptor, measuring the time interval of the pulse.

The resolution of acoustic systems mainly depends on the length and frequency of the pulse, higher frequencies providing higher resolution. However, these high frequencies are not able to penetrate into deep water.

PENTAX | W-800 SIMPLE OPERATION MODULAR SOFTWARE

TOUCH SCREEN

Large easy to use Color graphical touch display, alphanumeric keyboard

Auto Focus

COMPACT FLASH

CF-Card slot

Triple axis compensator on the W-822NX (2″) and W-823NX (3″) models

Hi-Speed USB · SD

Advanced connectiivity USB, SD-Card slot, RS-232C Data port

Automatic Atmospheric Correction

Windows CE

W-800 SERIES | R-400N SERIES | R-400VN SERIES

LONG RANGE EDM

Measures distances in reflectorless mode over 550 m and 9000 m (*) to a single prism while maintaining the same high level of accuracy.

Benefits: Its extended measuring range prevents you from making additional instrument setups.

(*) in good conditions (40km visibility)

TI Asahi Co., Ltd.
International Sales Department
Tel.: +81-48-793-0118
Fax. +81-48-793-0128
e-mail: international@tiasahi.com
www.pentaxsurveying.com/en/

Pentax Distributor for INDIA
LAWRENCE & MAYO PVT. LTD.
274, Dr. Dadabhai Naoroji Rd.
Mumbai 400 001, INDIA
tel: +91 22 22 07 7440
fax: +91 22 22 07 0048
email: instmum@lawrenceandmayo.co.in
www.lawrenceandmayo.co.in

JSIMA
Japan Surveying Instruments Manufacturers' Association

Member symbol of the Japan Surveying Instruments Manufacturers' Association representing the high quality surveying products.

For this reason, high frequencies are usually used in shallow waters. In very shallow waters (< 100 m) the measure accuracy under the best conditions is 2-3 cm. For depths up to 300 m, frequencies between 100 and 250 KHz are used. In deep waters (> 300 m), lower frequencies are used, typically between 20-50 KHz, which allows greater penetration.

These systems are mostly used in hydrography, especially the multibeam echo sounders. The main capabilities of multibeam systems are more vertical accuracy obtained in the measure, as well as more sea bottom coverage.

Non-Acoustic Methods

Airborne Systems: LIDAR Systems

Bathymetric LIDAR systems (Light Detection and Ranging) are based on a transmitter which sends light pulses that are registered by the sensor, and then the time those pulses take to return is measured. This technology applied at the marine environment is not new; in fact, laser pulses were used in the mid 1960's to detect submarines. In 1972 the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) started field testing of the Airborne Oceanographic LIDAR (AOL) for hydrography (Guenther, 1985).

The acquisition of bathymetric data is based on the measurement of the laser pulse's travel time. The transmitter sends a green beam (532 nm) and knowing its speed through both the atmosphere and the water column, the distance from the sensor to the seafloor is calculated. Therefore a laser pulse within the IR region is used to determine the sea surface, and to calculate the depth at the point using the height differences.

Since a light beam is used, it is affected by several factors that can produce a distortion on the signal received. The main reason is the presence of suspended material into the water column. The water turbidity is the principal determining factor that limits the use of these systems for hydrographic purposes. Consequently, the best conditions to obtain reliable data correspond to clear waters (Costa, B.M. et al., 2009).

Its use is limited to 50 m depth in clear waters offshore, because of the effect of light extinction in the water column with depth. If turbidity conditions are high the depth decreases to 10 m or less in coastal areas (Guenther et al, 2000).

In addition to the limitations because of environmental factors, limitations regarding the technology itself make the detection of small objects difficult. These systems do not ensure the detection of all of the seafloor features which are smaller than a cube of one meter side (Guenther et al, 2000). In this regard, areas with high relief may limit the accuracy of this kind of system compared with data obtained from multibeam systems (Costa, B.M. et al., 2009). The capabilities of this kind of method offer advantages in certain situations; it is a secure method to be used in shallow coastal waters, where ships may have difficult access, and it is suitable for areas with extreme temperature or salinity conditions.

Moreover, capabilities of LIDAR systems lie in the high speed data acquisition, and the lower number of tracks required to obtain full coverage of an area, because band width is independent of depth. These reasons reduce costs, and according to Guenther (2000), they can be from one-fifth to one-half that of waterborne techniques for adequately planned projects, these have similar results to those obtained in studies carried out in Sweden and Australia

In conclusion, LIDAR systems are applicable throughout the land/sea interface, and although far from maturity, they appear as an excellent choice complementary to multibeam systems (Guenther, 1985), by addressing the problem of the lack of data continuity in this area where a large numbers of physical, chemical and biological processes interact.

Satellite borne systems

Data acquisition by active sensors

Active sensors produce a pulse that is received by a sensor. Two sensors are used in the field of hydrography, the radar altimeter and the synthetic aperture radar (SAR).

Radar Altimeter

The use of radar altimeter for hydrography is based on the measurement of the return time pulse emitted by microwave radar operating in frequency of 13 GHz. This pulse is reflected by the sea surface, and the topography of the sea surface can be established with an accuracy of 0.03 m. If the height from the satellite above the ellipsoid is known, as well as above the sea surface, then the geoid height can be calculated, and transformed into gravitational anomalies. In deep waters, where the layer of sediment is thin, these anomalies tend to be correlated with variations of the bottom topography, inferring the shape of the seafloor (Sandwell & Smith).

Sandwell & Smith (1997) developed a map of the seafloor topography using altimeter data from the U.S. Navy's GeoSat Geodetic Mission and the European Space Agency's ERS-1 mission.

This method is applicable to meso-scale phenomena, such as ocean currents, plate tectonics processes, submarine volcanism or petroleum exploration.

Synthetic Aperture Radar (SAR)

The Synthetic Aperture Radar (SAR) is an active sensor that generates a pulse in the microwave region, corresponding to the C-band (5.3 GHz), collecting information relating to the roughness of the sea surface, as the result of the backscattered signal. These sensors are not used widely for the development of marine bathymetric models. However they are used by the Bathymetric Assessment System (BAS) developed by the Dutch company ARGOSS supported by ESA's Earth Observation Programme, developed within the framework of the BABEL project.

This method aims to produce bathymetric maps of coastal areas using SAR imagery from the ERS European satellite. It is based on the modulation of the flow speed in the sea surface produced by interaction

between tidal currents and the sea bottom, producing changes in the wave spectrum. These cause variations on the backscattered signal recorded by the sensor, therefore leaving registered bathymetric features in the image (European Space Agency, 2000).

Its spatial resolution corresponds to that of the SAR imagery (30 m). This model is applicable for shallow water areas up to 30 meters depth and do not comply with International Hydrographic Organization (IHO) standards for safe navigation (European Space Agency, 2000).

The main limitations of this method are those relating to the hydrodynamic conditions of the sea. This method is functional when tidal currents are greater than 0.5 m/sec and wind speed is between 3 and 10 m/sec.

Data acquisition by passive sensors

In this case, the sensor obtains information from the electromagnetic radiation previously issued by an issuer focus different from itself. The methods to obtain bathymetric data using satellite imagery are mainly based on the attenuation of optical radiation as it passes through the water column. Subsequently the relationship between attenuation and depth can be set.

To analyze the satellite imagery in order to produce information about sea bottom depth two types of algorithms are primarily used, the Lizenga's linear algorithm and the ratio algorithm (Stumpf, 2003). Both include parameters that have to be calibrated using field measures, and they are often specific site and environmental conditions (Lyons et al., 2011). For this reason, previous information about the environmental conditions of the study region is necessary to properly calibrate these algorithms.

Advances in these technologies allow improving spectral resolution, being able to evaluate the behavior of sea water to more specific wavelengths, increasing the accuracy of derived depth.

Moreover, recent satellites are improving its spatial resolution. Satellites as IKONOS or QUICKBIRD give a value of 3.28 and 2.84

m respectively for spatial resolution, being currently used for mapping coastal areas. In 2009 the WorldView-2 satellite was launched providing a spatial resolution of 1.84 m and a greater spectral resolution, offering new possibilities in bathymetric studies, as its operator, Digital Globe, assures.

This is a solar radiation-dependent method, so it faces several constraints common to all satellite imagery applications within the visible region of the electromagnetic spectrum, i.e. presence of clouds, luminosity conditions , etc. Concretely, maximum penetrations depths of solar radiation in the water column reach 20 m (in the blue region), consequently this method is only applicable to shallow waters.

Like in case of LIDAR systems, the signal received by passive sensors can be affected by the presence of suspended material; for this reason turbidity of water column limits their capabilities. We must also consider the albedo due to the bottom and the water surface glint, that can produce variations of the signal.

Its main advantages are in line with that of bathymetric LIDAR, i.e. to be a secure method for hydrographic works in shallow waters where boats cannot access. Therefore, it can be a solution to problems regarding to the lack of bathymetric data in coastal area and it can allow developing coastal terrain models (Hogrefe et al., 2008). In this case, the reduction of operation costs is significant, compared to LIDAR and multibeam systems. Its high temporal resolution is an important advantage too, because it offers more possibilities to choose an optimal scene to derive bathymetry. In addition, it is accessible to remote areas, where bathymetry data could not be obtained otherwise, or would result in higher costs.

Conclusions

Advances in technology offer more accurate measures, along with an increasingly software and hardware capabilities for data management, analysis and visualization. It helps to manage the marine and coastal environment in a better and more efficient way.

The field of application of depth measures has to be taking into account, because the vertical and horizontal resolutions vary depending on the scale of the study phenomenon. To assure the efficient use of available systems it is necessary to know the limitations of the method, as well as the factors that affect measurement process.

Bathymetric LIDAR systems are not a mature method and their technology is still in development. However, the use of satellite imagery to measure depths is evolving rapidly, and it shows a great potential to retrieve reliable depth measures. As a resume, satellite and LIDAR technologies can be complementary with multibeam echosounder measures, spreading the scope of knowledge and the possibilities of a better coastal and ocean use.

References

Costa, B.M., Battista, T.A. & Pittman, S.J. 2009, *"Comparative evaluation of airborne LiDAR and ship-based multibeam SoNAR bathymetry and intensity for mapping coral reef ecosystems"*, Remote Sensing of Environment, vol. 113, pp. 1082-1100, Elsevier.

European Commission, 2009, *"Building a European marine knowledge infrastructure: Roadmap for a European marine Observation and Data Network, SEC (2009) 499 final"*, Brussels.

European Space Agency, 2000. "Towards the operational use of ERS SAR for bathymetry mapping in Belgium using the advanced Bathymetry Assessment System: BABEL2", http://due.esrin.esa.int/prjs/Results/80-116-246-55_20031223212754.pdf

European Union, 2007, *"Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)"*.

European Commission, 2007, *"An Integrated Maritime Policy for the European Union, COM (2007) 575 final"*, Brussels.

European Commission, 2010, *"Marine knowledge 2020. Marine data and observation for smart and sustainable growth COM (2010) 461 final"*, Brussels.

Guenther, G.C., Cunningham, A.G., LaRocque, P.E. & Reid, D.J., 2000, *"Meeting the accuracy in airborne Lidar bathymetry"*, Proceedings of EARSeL-SIG-Workshop LIDAR, Dresden.

Guenther, G.C., 1985. *"Airborne laser hydrography: System design and performance factors"*, NOAA Professional Paper Series, National Ocean Service 1, pp. 385, Rockville, National Oceanic and Atmospheric Administration.

Guilford, J. & Palmer, M., 2008, *"Multiple Applications of Bathymetric LIDAR"*, Proceedings of the Canadian Hydrographic Conference and National Surveyors Conference 2008.

Hogrefe, K.R., Wright, D.J. & Hochberg, E.J. 2008, *"Derivation and Integration of Shallow-Water Bathymetry: Implications for Coastal Terrain Modeling and Subsequent Analyses*", Marine Geodesy, vol. 31, pp. 317, Taylor & Francis.

Lyons, M., Phinn, S. & Roelfsema, C. 2011, *"Integrating Quickbird Multi-Spectral Satellite and Field Data: Mapping Bathymetry, Seagrass Cover, Seagrass Species and Change in Moreton Bay, Australia in 2004 and 2007"*, *Remote Sensing*, vol. 3, pp. 42.

Sandwell, D.T. & Smith, W.H.F., 1997, *"Exploring the oceans Basins with satellite altimeter data"*, http://www.ngdc.noaa.gov/mgg/bathymetry/predicted/explore.HTML

Smith, W.H.F., Sandwell, D.T. & Raney, R.K. 2005, *"Bathymetry from satellite altimetry: present and future"*, OCEANS, 2005. Proceedings of MTS/IEEE, pp. 2586, Washington D.C.

Stumpf, R.P., Holderied, K. & Sinclair, M. 2003, *"Determination of water depth with high-resolution satellite imagery over variable bottom types"*, Limnology and Oceanography, vol. 48, pp. 547-556.

Look Closer.

LAND-PAK
StarFire + RTK Survey System

- ✓ Ultra RTK & RTK Extend™
- ✓ StarFire™ License Included
- ✓ Three Year Warranty
- ✓ Full GNSS Support
- ✓ Online Training Library
- ✓ All Accessories Included

www.LAND-PAK.com/positioning

NAVCOM
A John Deere Company

Comparing Global Geoids

The aim of this paper is the compute of geoid height grids over Morocco area from several GGM and EGM. Comparing these grids according to the criteria of best fitting GPS/levelling geoid height determinations is done. The best fitting Global Geoid for Morocco area is chosen

EL Hassan EL BRIRCHI
Mathematics Computing and Geomatics Department
Ecole Hassania des Travaux Publics,
Casablanca, Morocco

Pr Driss EL AZZAB
Geo resources and Environment Laboratory,
Technical Science Faculty,
Sidi Mohamed Ben Abdellah University,
Morocco

Rather than classical instruments and methods for collecting spatial data, GNSS facilitate and enhance collecting time and range.

GNSS 2D positioning accuracy is well defined. According to the receiver model, the software, the positioning Mode, the available corrections used, the 2D positioning accuracy vary from few meters to mm. However the altimetry positioning with GNSS is less accurate than 2D one.

Without an accurate Geoid reference earth surface, the levelling survey by GNSS couldn't be done with sufficient accuracy needed for several fields of survey like construction or water management projects.

As a step in the way of computing a precise geoid surface over Morocco, the aim of this paper is to compare global geoid models especially regarding the improvement shown in the spatial determination of the gravity field during the last few years.

Geoid Determination

Methods for computing geoid models

Geoid as physical earth reference surface is defined as an equipotential surface of the gravity field of the earth g. It is also approximated by the mean sea level to get a point with altitude 0 in order to fix altimetry datum and enable classical levelling.

The determination of geoid is meant as the compute of geoid heights from the reference ellipsoid. This is done by several methods:

– Computing geoid heights using global models of spherical harmonics coefficients. This method allows the determination of long or medium wavelength part of geoid according to the maximum degree and order of the model.
– In order to take into account the short wavelength part of the geoid we use gravimetric models which are based on transformation of residual gravity anomaly into geoid heights by the Stokes integral. The terrain effect is also computed especially in regions with rough topography
– Comparing ellipsoidal height measured by GNSS and physical height measured by classical levelling allow the determination of geoid height.

More details on these methods could be found in (Hofmann-Wellenhof and Moritz 2005)

Geoid determination over Morocco

Two gravimetric geoids are computed over the north of Morocco. The first one is MGG97 (Benaim et al 1997). It is based on OSU91A (Rapp et al 1991) as global geopotential model and a set of land measured free air anomaly points.

The second one is MORGEO05 (Corchette et al 2007). Improvement is due to the use of EIGEN CG01C (Reigber et al 2006) as global geopotential model for the estimation of long and medium wavelength. SRTM 90M as global digital terrain model is also used to take into account terrain correction in the determination of MORGEO05.

Global geopoteantial model

Spatial gravity missions

During the last decade three spatial gravity missions are launched in order to improve

the knowledge of the gravity field. These three missions are:

– CHAllenging Minisatellite Payload (CHAMP) (Reigber et al. 1996)
– Gravity Recovery And Climate Experiment (GRACE) (GRACE 1998)
– Gravity field and steady-state Ocean Circulation Explorer (GOCE) (ESA 1999)

The last one is launched by Europeen Spatial Agency (ESA) in March 2009 and proposes the determination of geoid until the wavelength of 200 km (resolution of 100 km). An improvement of accuracy is also proposed by GOCE: 1 cm for geoid height accuracy and 1 mgal for gravity anomaly accuracy.

Earth Geopotential Model

Several Earth Geopotential Models have been computed according to the spherical harmonic development of the gravity potential. Due to the limitation of the spatial methods some EGM included information from land measured gravity data in addition to the spatial data. A list of these models could be found in the International Centre for Global Earth Models (ICGEM).

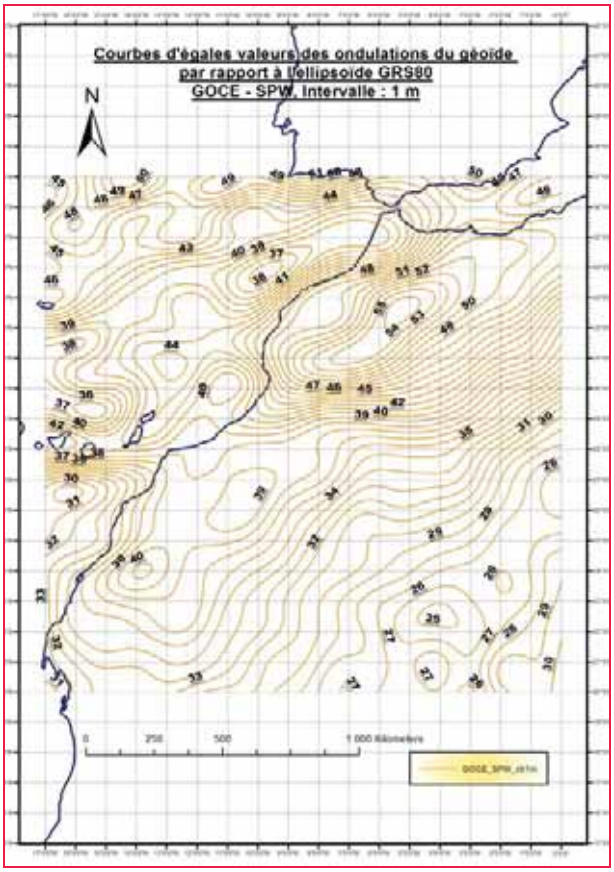


Figure 1: Contour Map for geoid height above GRS80 computed from GOCE Geopotential Model (Interval 1 m) (Source: EL BRIRCHI & EL AZZAB 2011)

Used Data

In this work we compare some EGMs to Geoid heights computed from GPS/levelling data. We use 20 GPS/Levelling points over the study area. The EGMs evaluated are:

- GOCE geopotential models provided by the European Space Agency.
- EGM96 (Lemoine et al 1998) developed until 360 maximum of degree and order
- EGM2008 (Pavlis et al 2008) developed until 2160 maximum of degree and order

Results

Figure 1 shows the contour map of geoid height computed above GRS 80 ellipsoid using GOCE geopotential model. This result represent wavelength of geoid until 100 km resolution.

After computing differences between geoid heights from GOCE, EGM2008 and EGM96 and from GPS/levelling determinations for the 20 control points we summarize statistics of the results in table 1.

We also limit the test for the region of Casablanca using only 10 GPS/levelling points. Results are in table 2.

We note that EGM96 used in this paper is corrected by a term of - 0.53 m to fit better WGS84 ellipsoid. From table 1 and table 2 we could conclude that EGM2008 is better than GOCE and the corrected EGM 96 on the criterion of small standard deviation. The choice of better global geoid for all the area of Morocco couldn't be done unless we use GPS/levelling points over all the study area.

Table 1: Statistics of results of comparing Geoid heights from EGMs and GPS/levelling

		GOCE (degree and order 201)	EGM2008	EGM96
Mean	Total of the 20 points	0,25	0,30	0,22
Minimum		-0,58	-0,35	-0,48
Maximum		0,80	0,72	0,52
Variance		0,08	0,06	0,07
Standard Deviation		0,29	0,24	0,27

Table 2: Statistics of results of comparing Geoid heights from EGMs and GPS/levelling

		GOCE (degree and order 201)	EGM2008	EGM96
Mean	10 points for the region of Casablanca	0,228	0,295	0,329
Minimum		0,148	0,269	0,175
Maximum		0,335	0,350	0,478
Variance		0,005	0,001	0,011
Standard Deviation		0,070	0,024	0,104

Results obtained for the region of Casablanca show that EGM2008 could be used for levelling by GPS. It is also possible because of smooth topography in this region.

Conclusion

New EGMs enhance considerably the determination of long and medium wavelength over Morocco. More tests are necessary to confirm the choice of EGM2008 especially in mountainous regions in Morocco where terrain effects should be taken into account.

References

Benaim E.H., Swassi A.M. & Sevilla M.J. (1997). The First Northern Moroccan Gravimetric Geoid. Journal of Physics and Chemestry Of the Earth, Vol. 23, No 1, pp 65-70. Ed Pergamon.

Corchete V., Chourak M., Khattach D. & Benaim E.H. (2007). The high-resolution gravimetric geoid of Morocco: MORGEO. Journal of African Earth Sciences, 48, pp 267-272.

EL Brirchi E.H. & EL Azzab D. (2011). Calcul d'un nouveau Géoïde au Maroc à partir des données de la mission de gravimétrie spatiale GOCE et utilisation des SIG pour sa validation par GPS et Nivellement. Geo Observateur Journal N° 19, CRTS, Rabat (IN PRESS)

ESA. (1999). Gravity field and steady-state ocean circulation mission. Rapport Spécial, ESA publication division, ESA SP-1233 (1), c/o ESTEC, Noordwijk, Netherland.

To Produce Results You Can Trust, Add STAR*NET to Your Workflow

From Data Collection ... To Network Adjustments ... To Your Final Deliverables

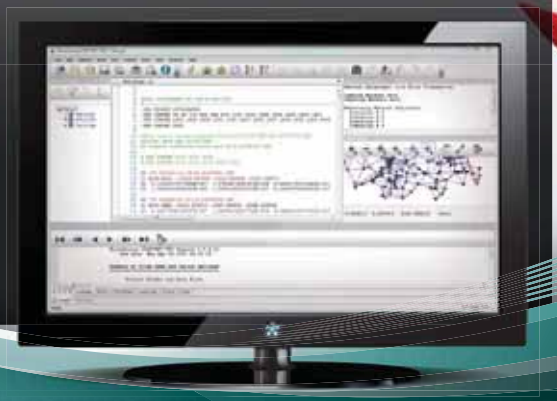
MicroSurvey STAR*NET is an easy-to-use application that adjusts 1D/2D/3D survey networks using rigorous least squares techniques. A strong least squares adjustment package can assist with current and upcoming positional tolerance standards.

Thousands of surveyors have trusted STAR*NET for over 20 years. Whether a survey consists of a single-loop traverse or a complex network of interconnecting traverses combined with GPS vectors, all observations are adjusted simultaneously to produce a single best-fit solution you can trust.

As with all MicroSurvey applications, STAR*NET is built to fit into your existing workflow.

Register for a FREE demo today!

Survey equipment and software vendors: are you interested in distribution opportunities? STAR*NET, like our other software, can be translated into any language. Visit our website for information about reselling STAR*NET in your area.



MicroSurvey®

www.microsurvey.com

Galileo update

Galileo to spearhead global search and rescue service

With an aim to pinpoint distress calls for rapid search and rescue, Galileo navigation system will be harnessed, announced European Space Agency (ESA). It will test expansion of the humanitarian system over the next two years to make it more effective. In addition to conveying distress signals to search and rescue organisations, Galileo will also provide a novel service known as Return Link Service. Under this innovative service, the satellite will send a reply to those in distress, letting them know that their signal was picked up and help is on the way.

Igor Stojkovic, engineer at European Space Agency (ESA) said, "Search and rescue packages are also being carried by US GPS and Russian Glonass satellites, though with most of Europe's Galileo constellation being deployed within the next few years, Galileo is leading the way."

For over 30 years, the international Cospas–Sarsat satellite relay system has been making air and sea travel safer, saving 24 000 lives along the way. Founded by Canada, France, Russia and the US, Cospas–Sarsat began with 'transponders' on low-orbit satellites. The low-Earth orbit satellites determined the location of emergency beacons using the Doppler effect as they pass overhead. "However, only a small area of Earth is covered at a time, and it may take valuable time to line up with a ground station to relay a message – and it takes two satellite passes to pinpoint the distress call," explained Igor.

With these satellites remaining in a fixed point in the sky, distress calls are detected and relayed immediately, although their relative lack of motion means Doppler-based ranging is not possible. "Now Cospas–Sarsat is moving to using navigation satellites in medium orbits," Igor stated.

"Navigation satellite constellations have been carefully designed for worldwide coverage, and can perform a combination of time- and frequency-based ranging for single-burst distress call positioning," Igor added. The first medium-orbit transponder was launched on a Glonass satellite last year, with two more flying aboard Galileo satellites due for launch at the end of summer. "These satellites will be the focus of our demonstration and evaluation phase, the results of which will set working standards for the operational system to follow from 2015," stated Igor. *www.esa.int*

Aggressive launch schedule for Galileo

March 23, 2012 Javier Benedicto, the head of the Galileo Project Office for the European Space Agency (ESA), set an aggressive schedule for launching some Galileo satellites as many as four at a time in 2014 and 2015, in an effort to meet a target provision date of Galileo's initial services in 2014 and full services in 2015. The announcement emerged at the Munich Summit on March 14.

The hurry-up to carry a further 22 satellites into orbit will get underway with continued dual-satellite launches aboard Russian Soyuz rockets, as was the case for the most recent in-orbit validation (IOV) launch in October, 2011. There will be three Soyuz launches in 2013, for a total of six new satellites boosted into orbit, and two Soyuz launches in 2014, adding four more.

GRACE. (1998). Gravity Recovery and Climate Experiment : Science & Mission Requirements Document, Revision A, JPLD-15928, NASA's Earth System Science Pathfinder Program.

Hofmann-Wellenhof B. et Moritz H. (2005). Physical Geodesy. SpringerWienNewYork, Autriche.

Lemoine, F.G., Kenyon, S.C., Factor, J.K., Trimmer, R.G., Pavlis, N.K., Chinn, D.S., Cox, C.M., Klosko, S.M., Luthcke, S.B., Torrence, M.H., Wang, Y.M., Williamson, R.G., Pavlis, E.C., Rapp, R.H., Olson, T.R. (1998). The Development of the Joint NASA GSFC and the National IMagery and Mapping Agency (NIMA) Geopotential Model EGM96; NASA Technical Paper NASA/TP1998206861, Goddard Space Flight Center, Greenbelt, USA.

Pavlis, N.K., Holmes S.A., Kenyon S.C., Factor J.K. (2008). An Earth Gravitational Model to Degree 2160: EGM2008; presented at the 2008 General Assembly of the European Geosciences Union, Vienna, Austria, April 13-18.

Rapp, R.H., Wang, Y.M., Pavlis, N.K. (1991). The Ohio State 1991 Geopotential and Sea Surface Topography Harmonic Coefficient Models; The Ohio State University, Department of Geodetic Science, Report No. 410, Columbus/Ohio.

Reigber C., Bock R., Förste Ch., Grunwaldt L., Jakowski N., Lühr H., Schwintzer P. et Tilgner C. (1996). CHAMP Phase B-Executive Summary. G.F.Z., STR96/13.

Reigber, C., Schwintzer, P., Stubenvoll,R., Schmidt,R., Flechtner, F., Meyer, U., König, R., Neumayer, H., Förste, C., Barthelmes, F., Zhu, S.Y., Balmino, G., Biancale, R., Lemoine, J.-M., Meixner, H., Raimondo, J.C. (2006). A High Resolution Global Gravity Field Model Combining CHAMP and GRACE Satellite Mission and Surface Data: EIGEN-CG01C; Scientific Technical Report STR06/07, GeoForschungsZentrum Potsdam

“ More than 30% savings. No downtime. Certainly the best GNSS solution investment we ever made.”

Outstanding performances at a fraction of the cost

The X91 GNSS RTK brings together world leading 220 channels GNSS technology, ultra-rugged field computer with integrated 3.5G modem for seamless RTK corrections management, and versatile data collection software.

By combining decades of positioning and surveying know-how, the X91 GNSS is one of the most powerful GNSS RTK solutions at a price point that every surveyor can afford.

Dealer Opportunities Available

www.chcnav.com I sales@chcnav.com

Starting another decade...

A report on Munich Satellite Navigation Summit 2012 held during 13 – 15 March 2012, Munich, Germany

With the slogan "GNSS and Security" the Munich Satellite Navigation Summit started a new decade of conferences and mentioned that this unique European Satnav-conference has its 10th anniversary. The organizing institute ISTA (which was former known as Institute of Geodesy and Navigation) from the Universitaet der Bundeswehr Muenchen, invited high-ranking speakers from all over the world to discuss the progress and challenges of GNSS. The traditional Opening of the Summit in the beautiful Court Church of All Saints was highlighted by a very broad and interesting panel and a strong-voiced and colorful "a cappella" choir to pause for a moment. Prof Dr Bernd Eissfeller – chairman of the Munich Summit Committee and director of the organizing Institute – welcomed the guests from 24 countries and recalled the key achievements of the Summit making it to a successful platform for networking, discussing and presenting news in satellite navigation.

GNSS and Security

Dr Ronald Mertz, Ministerialdirigent at the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology appreciated the achievements of the Galileo program in the previous year, mentioning the two IOV satellites in orbit supervised from Galileo Control Center in Oberpfaffenhofen. According to the Munich Summit´s motto "GNSS and Security" Torsten Staffeldt (Raporteur for Aviation and Space Travel of the German Bundestag) stressed the importance of GNSS for security. Security is a critical issue. Galileo PRS will give new opportunities. Joel Szabat (Deputy Assistant Secretary for Transportation Policiy, Washington DC) pointed out that there was too little transparency in GNSS in the past and too much focus on the "enemy".

Presenters of 'GNSS and Security' session

Variety of Topics – Variety of Nations

In 2012 the Munich Satellite Navigation Summit came up with a broad variety of interesting topics as well as an international mix of experts presenting regional, global and augmented systems. Nevertheless, two of the 2012 highlights were the Session on "COMPASS" presented by the Chinese delegation and the Session "Galileo and Security" which was chaired by Prof Vidal Ashkenazi (Chief Executive of the U.K.-based Nottingham Scientific Ltd.). He asked his panel members if it should be possible for certain countries to become PRS participants through separate agreements. Edgar Thielmann (Head of Unit GP3 of the EC in Brussels) said "We see the risk and we want common rules on this." He further pointed out that through giving PRS to the hands of a third country the whole union can be put into risk. Carlo des Dorides (Executive Director of the GSA in Brussels) stressed that next to the EU 27, there are countries who are involved in PRS development and countries applying for EU membership. Alain Bories (OHB AG Bremen, Germany) added that from the industrial point of view, PRS is an interesting segment and the possibility to external companies to enter should be granted.

Big Day for a Small Girl

Special guest of the Munich Summit was the German winner of the European Commission's Galileo drawing competition. Doresa (11 years) from the Theodor-Storm-Primaryschool in Berlin Neukoelln - presented the winning picture "in cosmos" and her trophy. The Galileo Children's Drawing Competition was open to children born between 2000 and 2002 in the 27 EU Member States. Participants were asked to draw a picture on the theme "space and aeronautics" using any material they wished. The Galileo Satellites will bear the names of the winning artists. A satellite named after Doresa will represent Germany in orbit soon.

The Munich Satellite Navigation Summit thanks all partners, speakers, sponsors, exhibitors and attendees who made the Summit again a success. The Munich Summit 2013 will be held February 26.-28., 2013.

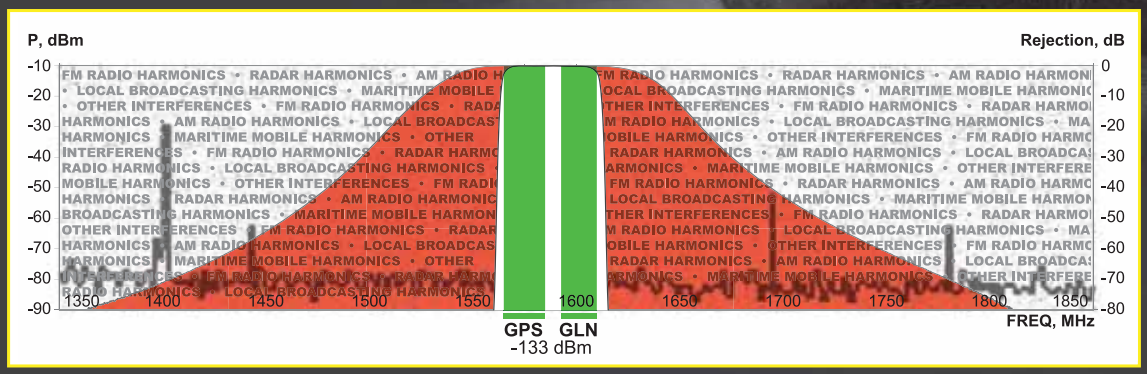
– Heike Haas
heike.haas@unibw.de

JAVAD

Galileo Galilej

With or without LightSquared

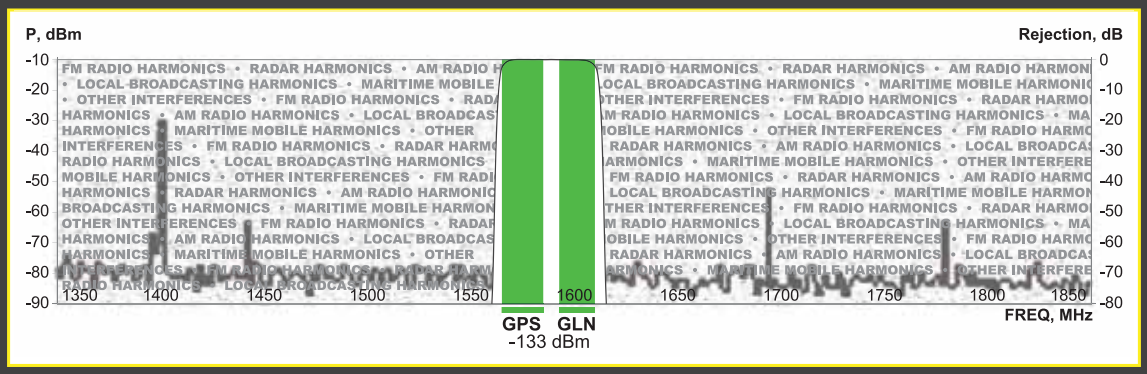
This filter is bad



It invites more white noise and other unwanted signals in and degrades performance (with or without LightSquared).

They say they cannot build anything better!

This filter is good



It brings every drop of GNSS signals in undisturbed, protects against unwanted white noise and other interference, and provides better performance.

They say they cannot build this, it is too difficult!

Controller for Field Applications

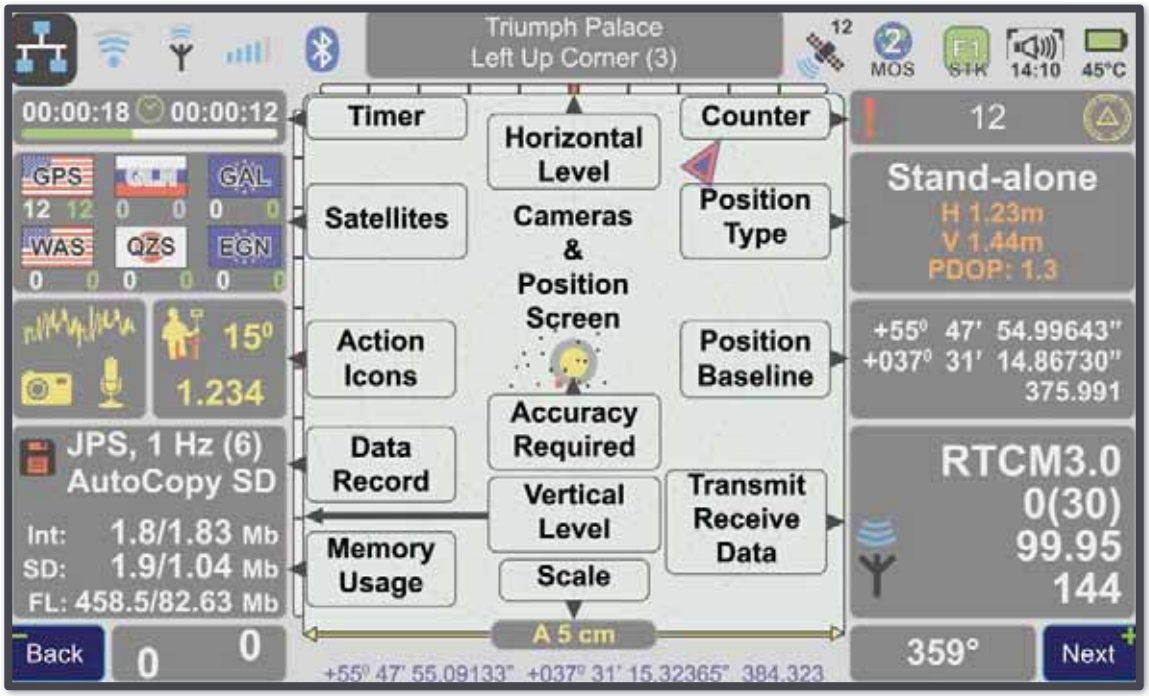
VICTOR-VS

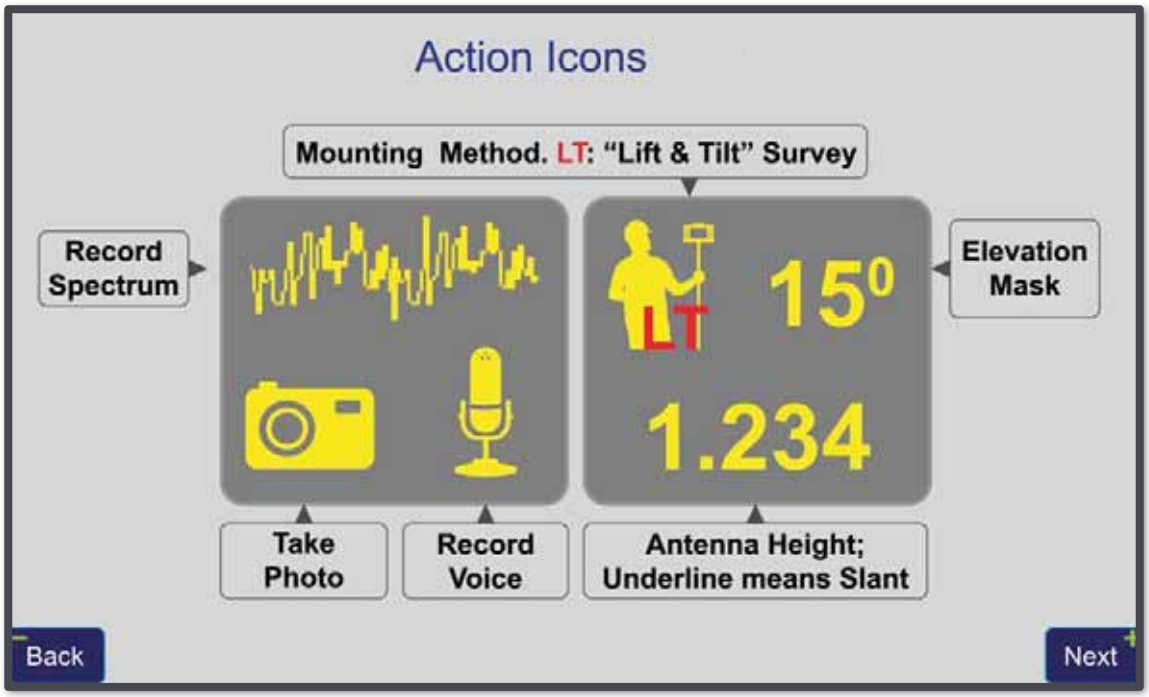
We complete our receivers with an ultra-rugged Windows CE controller for Field Applications. VICTOR-VS is powerful, waterproof, shockproof and versatile.

- **Loaded with Revolutionary Software**
- **4.3-inch display of 800x480 pixels**
- **Two 24+ hours rechargeable batteries**
- **Integrated camera 3 Mpixels**
- **Rugged, lightweight**

Action Screen shows status of all

• After you define Settings and select your desired operation, click the Action button to take you to the Action screen

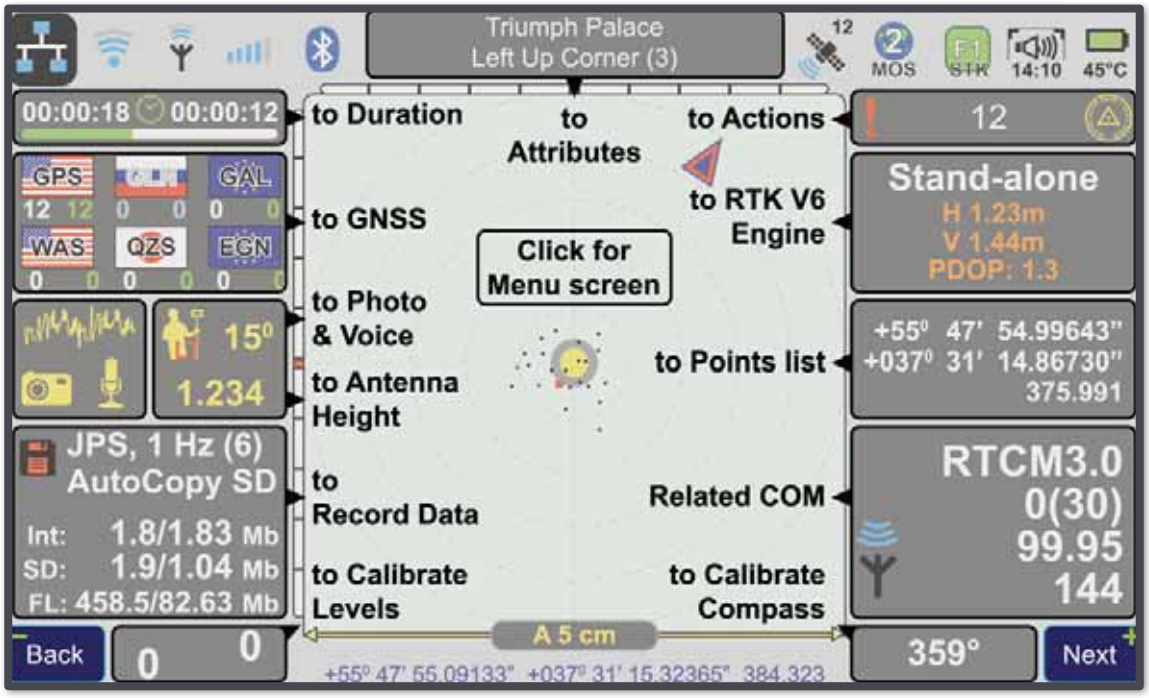


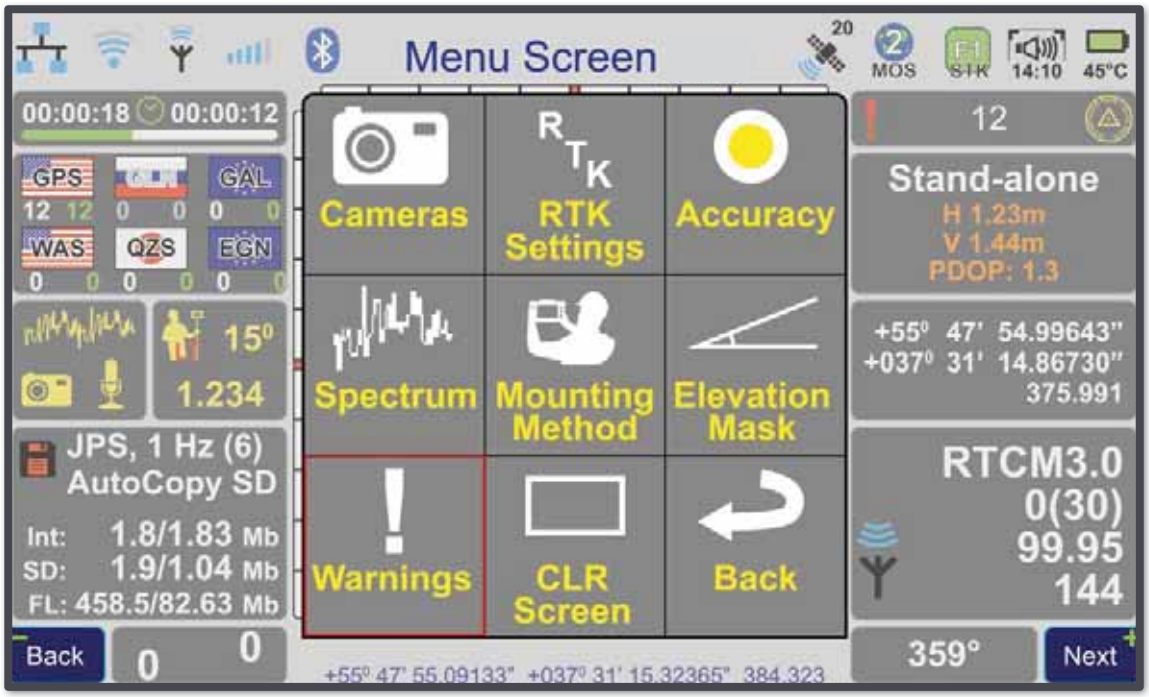


• In Lift & Tilt mode ("**LT**") you only need to lift the unit to near vertical on top of the survey point to start survey and then to tilt it to end the survey.

All segments/icons are active

Most functions can be reacted by a single click.

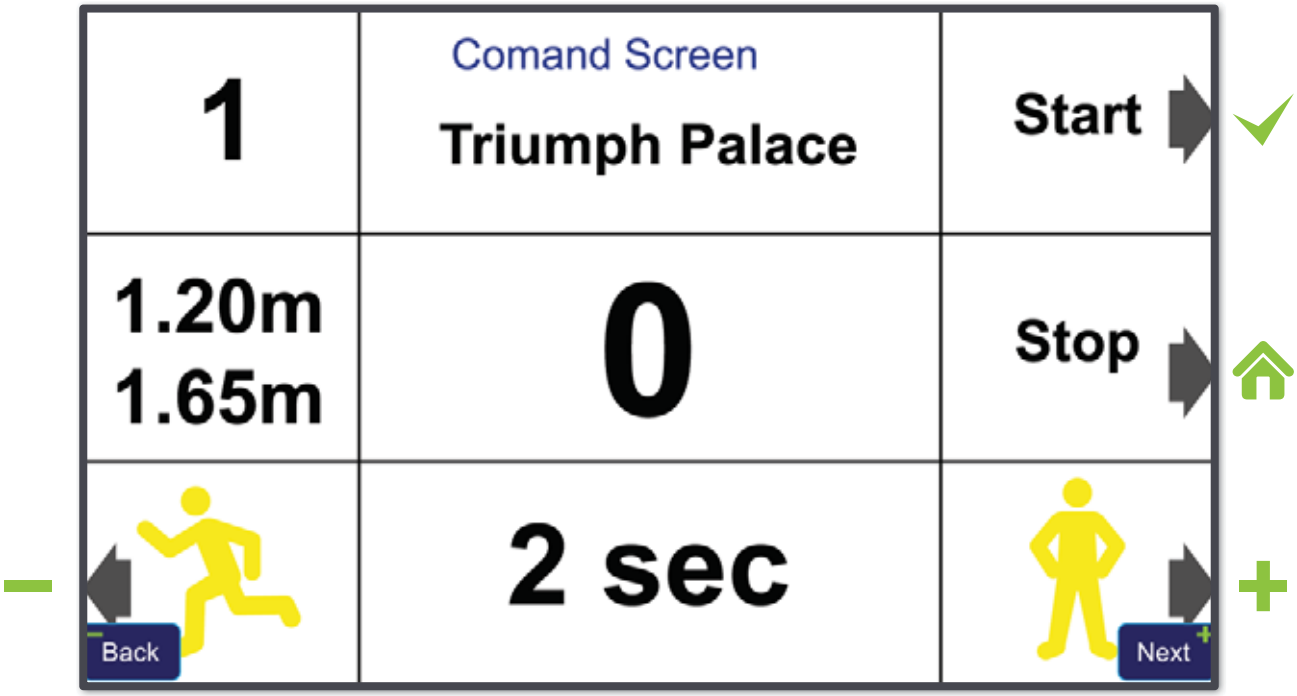




- "!" Indicates error messages or warnings exists. Click the "Warning" symbol in the Menu screen.

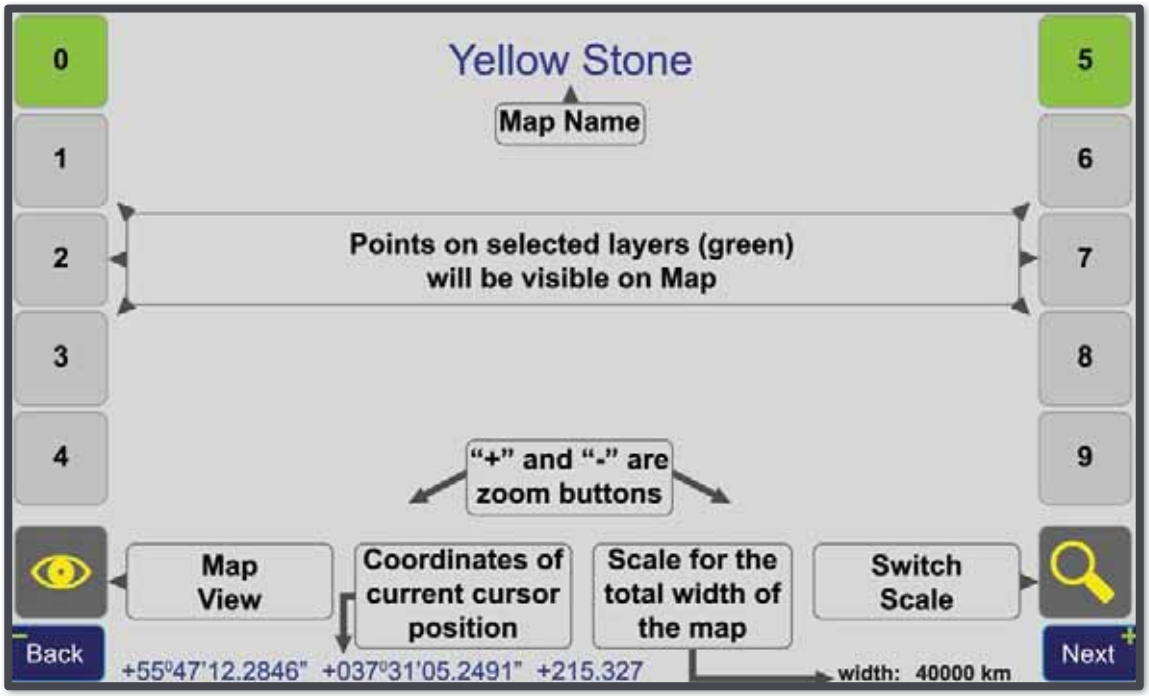
Command screen starts/stops & controls

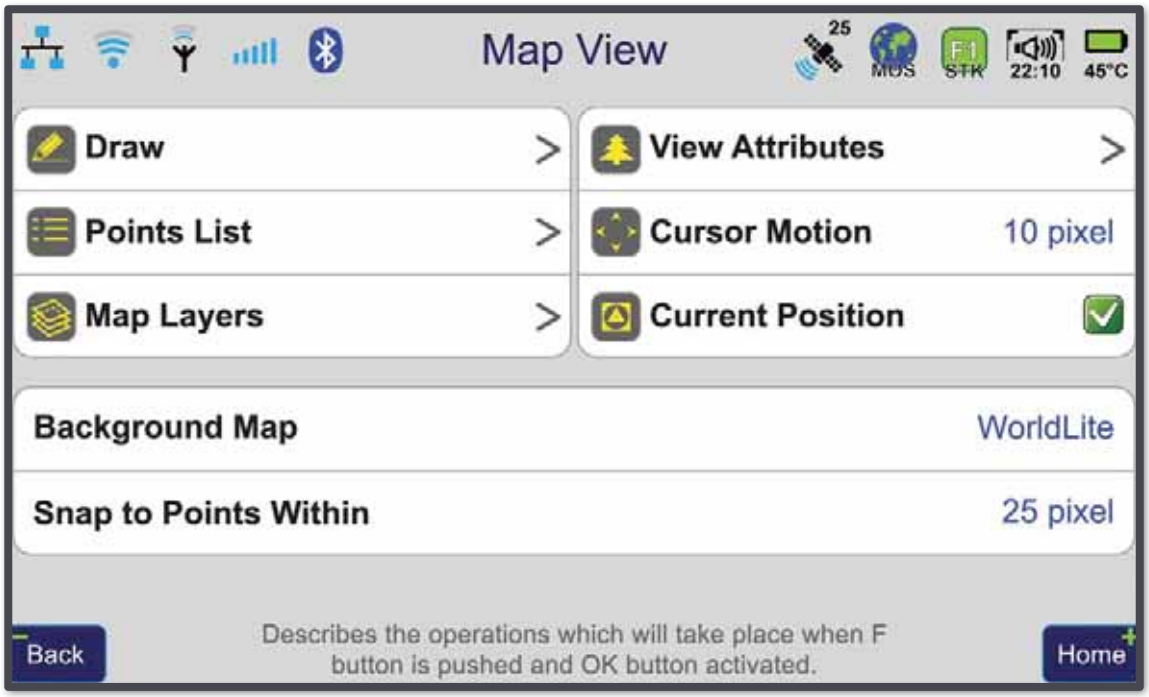
- Shows some important items in large fonts and allows to start/stop act and command other actions, depending on the current action.



Active map shows positions on active map

• Points, and their attributes, are stored in the selected layers of the Current Map.





Complete RTK rover unit

TRIUMPH-VS

3 Products Packaged in One!

1. High precision all-frequencies GNSS Antenna GPS+GLONASS+Galileo
2. Revolutionary, compact, 216-channel GNSS Receiver
3. Breakthrough, wide-screen, high-resolution handheld controller

For the latest GNSS news and technical information visit www.javad.com

The Missing Observation: Orthometric Height

The aim of this paper is to declare the limitations of GPS observations and the importance of orthometric height and how it is computed in the traditional GPS work.

Mohamed Eleiche
Geoinformatics
Consultant
GeoTiba Systems

Although the revolutionary GPS observations system delivers instantaneously the coordinates of a point with high accuracy, still another quantity, which is the orthometric height, needs also to be determined. Unfortunately, neither the orthometric height nor the geoid undulation can be observed directly. The aim of this paper is to declare the limitations of GPS observations and the importance of orthometric height and how it is computed in the traditional GPS work.

Introduction

The determination of the coordinates of a point on the earth surface with high accuracy is a real contemporary challenge. Although we are today (2011) equipped with arsenal of unprecedented electronic surveying devices (GPS) receiving positional signals from dozens of satellites orbiting the earth in addition to online public and private geodetic networks broadcasting measurement enhancement, we still didn't reach the required positional accuracy over our earth globe. The GPS delivers two quantities, which are latitude and longitude, and still the third quantity, which is the orthometric height, is not directly observed. The modern geodetic accuracy requires a centimeter level for the three coordinates describing a position on earth.

The purpose of this paper is to declare the real capabilities of GPS and the importance of the orthometric height in geodetic measurements and how it is currently computed.

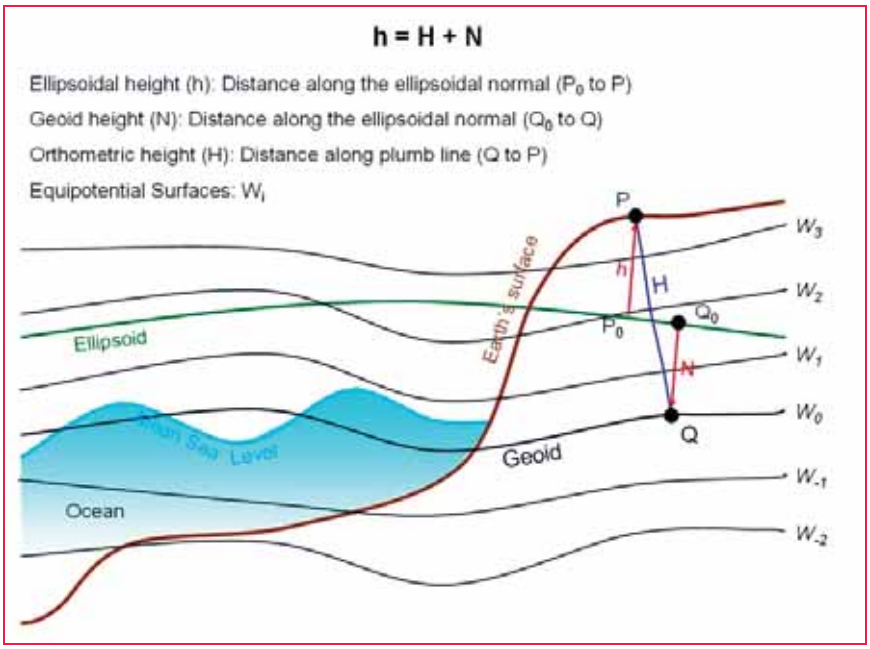


Figure 1: Relation between geoid and ellipsoid (Courtesy Natural Resources Canada www.nrcan.gc.ca)

Combined Coordinate Reference Systems (CRS) in Geodesy

In physics, usually a unique Coordinate Reference System (CRS) is used to describe a position in three dimensions (or four dimensions) quantities. However, the earth shape is very complex and irregular, and it is in dynamic state and always changing due to several parameters such as earth rotation around its vertical axis, earthquakes, and other. In geodesy, two different CRS are used to describe the position on earth surface and each one has different observation methodology. This combined (dual) CRS used in geodesy is a main source of confusion and requires bold clarification.

In geodesy, two coordinate reference systems (CRS) are used, geometrical CRS and geophysical CRS. The GPS delivers all the required observations for the geometrical CRS.

The first CRS is the ellipsoid system, recently based on WGS84 ellipsoid with its center coincides with earth geocenter. This CRS is also known to be geometrical 3D reference system, as the position of a point can be achieved by geometrical observations.

The second CRS is the geoid, which is not a geometrical shape, rather it is a physical (geophysical) reference. The geoid is densely defined in geodesy and geosciences' literature. The most common definition for geoid is its representation to the geopotential surface, where the gravity force is equal. The water surface of the earth is coincident with the geoid inside the water on earth (75% from earth surface is water), and it is continued under the earth crust as imaginary surface. Assuming that W_0 is the potential energy of the geoid (at the present mean sea level), by definition:

$W_0 = 62{,}636{,}860.850\ m^2\ s^{-2}$

It is required to compute the value of the height (H) of the observed point above (or below) the geoid. This height (H) is called orthometric height or physical height, as shown in Figure (1).

GPS Observations

Before GPS, the latitude and longitude were computed from geodetic observations, such as baselines, triangulation, and trilateration. After the GPS era, these two quantities are computed directly from GPS observations in addition to the height of the observed point above the WGS84 ellipsoid, which is observed and determined directly for the first time in the history of geodesy. The GPS delivers four quantities for the observed point, which are the latitude (L), the longitude (B), the height above (or below) ellipsoid (h) and time of observation (t). The quantities (L, B) are angular values in degrees and ellipsoid height (h) is in meters. All these quantities are delivered in the famous CRS named WGS84.

Orthometric (Physical) Height

By its definition, the physical height (H) of a point is the distance between the point and the geoid surface as shown in Figure (1). Unfortunately, there is no direct methodology known to compute the orthometric height (H) directly. The geoid itself is an imaginary subsurface and it has only geophysical definition with a defined potential energy.

The Classical Leveling Technique

Long away, the water surface of the earth was considered as a homogenous equipotential surface and a datum for vertical observations. Hence, most of the height measurements were measured by leveling from the Mean Sea Level (MSL). Scientists and engineers criticize the leveling for main reason, it uses horizontal plan (datum) for relative height difference while the datum used for height is the geoid which is not horizontal, rather it's irregular.

Geoid Undulation (N)

After the GPS era, a new quantity was observed directly, which is the ellipsoid height (h). The direct computation of ellipsoid height (h) motivated the observation of the undulation (N) between the geoid and the ellipsoid WGS84, and compute the orthometric height (H) from the equation relating (h, H, N) at a single point:

$H = h - N$

In case (N) is known and with the value of (h), the orthometric height (H) can be computed. Unlikely, the geoid undulation (N) cannot be observed directly at point (P). It needs gravity measurements and sophisticated computations. The separation (N) between the geoid surface and the WGS84 ellipsoid vary approximately to the range between -100m to +70 m all over the earth globe.

The GPS observations deliver the ellipsoid height at the point of interest, which is considered a revolution in geodesy, where before this value was difficult to compute or determine directly. Also, there are several modern methodologies for computing the geoid up to one centimeter accuracy using satellite technology, field gravimeters, and advanced mathematical models.

Practical GPS Observations

In traditional GPS observations, it is required to deliver the coordinates of the observed points in the geodetic dual CRS (L, B, H), and this impose the necessity to compute the orthometric height (H). The common practice is to model the geoid surface (N) in the observation area and compute the orthometric height from $H = h - N$.

Conclusion

In geodesy, two coordinate reference systems (CRS) are used, geometrical CRS and geophysical CRS. The GPS delivers all the required observations for the geometrical CRS. It is a real revolution in geodesy, it introduced a fast and accurate technique to determine the latitude and longitude of a point, in addition to the value of its ellipsoid height. However, still an important value not yet directly observed for the geophysical CRS, which is the physical (orthometric) height. Leveling is not an accurate methodology for physical height measurements. The value of the geoid undulation from ellipsoid is an important quantity and is necessary to be known. The traditional GPS observations include geoid modeling for area of interest for the computation of the orthometric height.

Finally, a new methodology is required to compute directly in field the geoid undulation and orthometric height.

Qmini

GIS Handheld Collector

- Adopts 20 channels:16-channels for L1+carrier phase
- Multiple working modes:SBAS,Real Time, Post processing,Static,ect
- Graphical interfaces convenient calculation functions for length, distance and area
- Mature international coordinate system conversion algorithm
- Built-in 2 million pixels camera,alone with image marking function
- Dust & water proof design:IP67
- 3.5" color touch-Screen for fieldwork

www.gnss-gps.com

Target On No.1 GNSS Brand

CE

HI-TARGET

Hi-Target Surveying Instrument CO.,Ltd
ADD: 10th Floor, ChuangxinBuilding, Tian'an Technology Zone, No.555, North of PanyuRoad, Panyu District, 511400,Guangzhou City, China

PACIFIC CREST

Carlson

GAGAN: Building block by block

In GNSS User meet organised by Induan Space Research Organisation on Feb 23 2012 at ISRO Banglaore many scientiest were honoured for their contribution to GAGAN (GPS Aided GEO Augmented Navigation) program of India. We present here views and experiences of some of the scientists who toiled hard and were behind this ambitious project

GAGAN and IRNSS pose complex and unique challenges

P Soma
Ex Project Director
Ground Segment, ISRO

GAGAN, a joint project of Airports Authority of India (AAI) and Indian Space Research Organization (ISRO), is a Satellite Based Augmentation System (SBAS) to the GPS. It augments the "Raw" GPS signals with the necessary corrections for meeting the accuracy, integrity, continuity and availability requirements specified for aircraft navigation over Indian fIight Information Region. IRNSS is an indigenous Satellite Navigation System that will provide autonomous geospatial positioning with regional coverage. With 7 satellites in GEO/GSO it will provide all-weather navigation in the Indian Landmass and 1500 km beyond its geopolitical border. GAGAN seeks to enhance the accuracy of GPS system while IRNSS seeks to form an independent navigation system. GAGAN is safety of life system whose requirements are very stringent with availability target of 99.999%, accuracy and precision levels also to be very high. Since this was the first time such a system was setup in India, it posed unique and daunting challenges in the development of the ground segment. We shall look into a few of them.

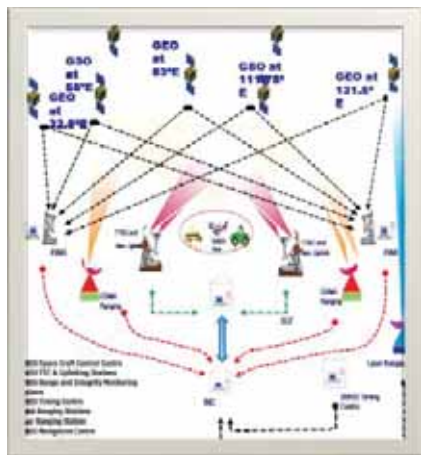
In GAGAN, corrections to GPS in terms of ionospheric error, clock error and ephemeris error are provided by the ground segment. It also determines integrity of navigation and alarms the user within 6 seconds (of occurrence of HMI).This places stringent specification on robustness of subsystems and the equipment that need to have built-in redundancy at all levels.

Monitoring of GPS satellite signals and Ionosphere is done by a set of widely separated Reference station (INRES), whose choice of location is critical to the mission. Extensive simulation exercises were done to choose the number and location of the various INRES sites. Multi path signal at INRES is critical performance driver of GAGAN. Elaborate multipath and interference survey of each site was done using extensive measurements and special analysis tools. In order to ensure the availability, each INRES had to be built with three independent chains of receivers. RF interference of Radars and other equipment operating in these frequencies had to be detected using special equipment and mitigation measures were taken involving significant effort and interagency coordination.

The uplink station (INLUS), which interfaces with satellite to broadcast the correction signals, comprises of signal generation unit and RF unit with 11 m antenna. The 11m antenna and RF systems were indigenously developed and operationalized. Designing a combined feed system for INLUS was a major challenge, and required extensive experimentation and several iterations to arrive at the final design.

Master Control Center (INMCC) is the nerve center for the GAGAN project collecting endless data performing navigation software function with attendant computer system, well supported by reliable communication links. INMCC availability requirements placed stringent configuration and infrastructure constraints on various facilities. Fully redundant terrestrial communication links were implemented connecting most the INRES to INMCC. For INRES at some locations only satellite links could be used. Outages in communication links proved a bottleneck during technology demonstration phase reducing the availability of the system and the last mile problem at Bangalore was solved by implementing multiple layers of dedicated Fiber optic links.

IRNSS is designed to provide PNT (Position, Navigation and Time) services with position



to an accuracy of 20 m and time to an accuracy of 10 Nano seconds. Critical technologies in the ground segment are

1. Reference receiver development (S and L band)
2. Establishment of precision timing facility (<10 nano seconds)
3. CDMA/Laser ranging of the satellite (centimeter level accuracy at 36000 km)

Of these, IRNSS precision timing facility needed the establishment of an independent Time scale. With no prior experience of architecting such a system it was a major challenge to establish the design of this system. Through considerable research and analysis the system was finalized as an ensemble of Hydrogen maser and Cesium clocks, robust processing algorithms and other related hardware. Presently the facility is undergoing stability tests. A special feature of IRNSS ground segment is centralized monitoring and control of the diverse elements of the ground segment. High levels of automation were achieved using software that was conceived, designed and developed in-house. Using this all the elements of the ground segment can be controlled from a single console.

GAGAN and IRNSS are technologies that have been envisioned to leapfrog India into a select group of countries with their own navigation systems. The nature of the requirements from these systems required the implementation of cutting edge technology, posing its own set of complex and unique challenges. Overcoming these challenges required innovative thinking and team effort, pushing the limits of technological expertise and project management skills. Team GAGAN consisted of engineers from AAI and experts from ISRO working together as a well knitted unit, while IRNSS is being developed by ISRO solely. On a personal note it was a stimulating experience to lead the establishment of the ground segment in the initial phase. Currently with all the elements of ground segment ready and GSAT-8 already providing the signal in space, GAGAN is entering the certification phase. Most of the elements of IRNSS ground segment have been established and IRNSS is envisaged to be fully operational by 2015. These crown jewels of Indian Space implementation will serve as the guiding light to the country well into the future.

Thank you Team GAGAN

Dr S Pal is currently the Satish Dhawan Professor and Senior Advisor for Navigation. He held posts of AD- ISAC, DD-Comm&tDigital Systems Area. He was Programme Director of Satellite navigation Programme. Under his able leadership and technical guidance the GAGAN & IRNSS Projects were conceptualized and initiated.

Dr S Kibe has retired as Programme Director, Satellite Navigation Programme from ISRO HQ. Primarily an architect for initiating the Space Based Augumentation Project (GAGAN) in ISRO, he was also responsible for interfacing with other GNSS systems and represented ISRO in various international Navigation forums.

P Soma retired as Deputy Director, Navigation Systems Area, ISTRAC. He held the post of Project Director -Ground Elements for GAGAN & IRNSS Projects and was responsible for all the ground segment infrastructure and establishment of ground stations spread across India.

A K Sisodia retired as Group Director in SAC. He held the post of Project Director, Navigation Payloads for GAGAN * IRNSS Projects and was responsible for design & delivery of Navigation Payload for GAGAN-SBAS system.

G J Das retired as Senior General Manager, NSA. He also worked as Project Director, Ground Segment Network-Satellite Navigation Program and was responsible for ground segment infrastructure primarily for GAGAN-FOP and IRNSS projects. The current magnificent INMCC building at Kundanhalli for GAGAN and INC at Bylallu for IRNSS is testimony to his contributions.

K Elango retired as Deputy General Manager, NSA, & DPD, IRIMS-Ground Segment from ISTRAC. He was primarily responsible for carrying out the noise and multipath surveys and establishment of Reference stations for GAGAN/IRNSS projects.

Sampath Kumar retired as Manager, Terracom from ISTRAC & held the post of DPD, IRDCN (IRNSS Data Communication Network). He was primarily responsible for establishment of Communication network for GAGAN & IRNSS Projects.

(Late) Rajneesh Gupta held the post of Deputy Project Director, GAGAN. He was also associated with Development of Navigation Software for GAGAN & IRNSS. He conceptualized and worked for the realization of GAGAN-FOP project, contributed to Iono Model Development and Realization over Indian Region. Sadly not amongst us but will always be remembered.

Mantaiah retired as Head, Data Transmitters Division from Communication Systems Group. He has contributed to the incorporation of Satellite Positioning System in IRS projects. He was associated with IRNSS in the capacity as Consultant.

MLN Sastry held various posts of Deputy Head, PPEG & Head, Components Division of ISAC prior to joining GAGAN-TDS. He was responsible for all budgetary aspects of GAGAN-TDS.

K N S Rao retired as Project Director of IRNSS. He was wholly responsible for demonstrating the GAGAN TDS system as proof of concept of Satellite Based Augmentation system over India. GAGAN-TDS project was a frontrunner for current GAGAN-FOP Project. Also honored were the scientists Mr Sivaraman for his contribution in Indian Iono Model Development and Mr Bandopadhyay for navigation payload.

GAGAN-TDS is a path breaking project on many counts

K N Suryanarayana Rao
Former Project Director, GAGAN-TDS, ISRO

GAGAN-TDS is a path breaking project on many counts. It is one of the first major projects in the country in the field of Satellite navigation. TDS represents the Technology Demonstration System referring to the first phase of the spiral deployment of the SBAS system in the region. GAGAN-TDS was taken up by ISRO in collaboration with Airports Authority of India.

It was in late 1999 that I was asked to lead the project as the Project Director at ISRO Satellite Centre, Bangalore. As I progressed into making the detailed project report it was evident that the project was challenging than what was understood because of the following:

- Need to Implement a whole complement of Satellite Navigation elements including the Ground and Onboard Infrastructure for the first time in the country with specifications meeting stringent International Standards for Civil Aviation
- Need to carry the TDS phase elements to the operational phase, To save time and money
- Somewhat complex behaviour of the Ionosphere compared to other regions

The drawing up of the detailed specifications itself was a daunting task. GAGAN-TDS project had to learn from the experience of the US and the European teams who had implemented similar systems earlier in order not to repeat costly mistakes. A lot of efforts went in selection of the State of the Art equipment which will not become obsolete for many years. The services of independent International consultants were utilised particularly for ensuring that the system is suitable for eventual certification. A combined team of workforce drawn from both ISRO and AAI was created for execution. Managing diverse working teams proved to be difficult in the beginning but the related problems were overcome due to the support available from the management of both ISRO and AAI.

The development of the Ground infrastructure at so many locations for the reference stations presented many difficulties. A number of hurdles had to be crossed even before the work could start at the respective locations. An elaborate site survey had to be conducted for meeting stringent criteria for RF Interference and Multipath. Similar hurdles had to be crossed for the establishment of 18 TEC stations across the country for understanding the behaviour of the Ionosphere. The maintenance of these stations, collection of the data, and the subsequent analysis by various institutions threw enormous challenges hitherto not attempted. Volumes can be written about the hassles faced during the transportation and installation of sensitive equipment like the Atomic Clock at remote Reference Station locations. Ensuring continuous operation in these unattended stations was not easy. The establishment of Mission Control Centre and the Uplinking Station at Bangalore was unique and presented its own set of problems. Thanks to the skill and the dedication of the project team, the work was completed meeting all the objectives. This Infrastructure, in fact, proudly showcases the GAGAN-TDS achievements to the outside world drawing praise from the visiting dignitaries.

The development of the L-Band L1/L5 Navigation transponder for GAGAN-TDS was taken up at ISRO. This task proved to be tough given the fact that the latest FAA specifications were made applicable. The SAW filters required for the Transponder had to be indigenously developed for the first time as the project faced export restrictions for the supply of the item. When the development was completed it marked a big milestone since this system had the best specifications so far for any SBAS Navigation Transponder. As the launch of the satellite took more time than earlier planned, the project had to think of alternate means to qualify the Ground system. The project could get the services of the INMARSAT SBAS L1/L5 Transponder on temporary basis for the integration of GAGAN-TDS Ground system and establishment of the Signal in Space. During the GEO satellite integration, a number of technical problems were faced which at times was very frustrating. The combined efforts of the project team and the vendors of the equipment made it possible to solve the problems and to fine tune the system for performance. This was a real learning experience for the entire team. The availability of dedicated communication links linking all the stations to the Mission Control Centre, on a continuous basis meeting the stringent SBAS standards is very vital and it was found to be difficult to achieve on a continuous basis. The RF Interference and Multipath environment can change and it caused some problems. The successful GEO Integration culminated with the System Acceptance Test. The results were very encouraging. The subsequent test using a user receiver onboard a special aircraft also yielded good results. This marked the successful completion of the TDS phase.

The lessons learnt from GAGAN-TDS have been the basis for the Operational Phase which is presently in progress. Experience gained in GAGAN-TDS for the creation of the Infrastructure, development of the Navigation Software and the handling of the Ionospheric corrections will be very valuable for the Operational Phase of GAGAN as it clearly spells out the improvements required in the system configuration as well as the Ionospheric Corrections strategy.

As I look back, it is a matter of great pride and satisfaction for me to have been associated with such a path breaking project like GAGAN-TDS which in my opinion is far more than a Technology Demonstration System. I salute the GAGAN-TDS team members who made it possible.

Coordination of spectrum in GNSS is of utmost importance

S V Kibe
SATCOM & GNSS Consultant, Former Program Director, SATNAV, ISRO HQ Bangalore, India

Satellite Navigation is, by its very nature, a global program. The Indian Space Research Organization (ISRO) started the Satellite Navigation program in the early nineties. The International Civil Aviation Organization (ICAO) had prepared a report on Future Air Navigation System (FANS). The FANS report prepared by the member States recommended Satellite Navigation as a primary FANS technology for civil aviation for Communications, Navigation and Surveillance. The US with GPS and Russian federation with GLONASS had by then launched their global systems. By 1996, GPS had completed its constellation with 24 satellites in MEO orbit. GLONASS had more than 22 satellites by then but the number of satellite went down subsequently until 2002 when Russia revamped the GLONASS system. Today GPS has 31 satellites and GLONASS 24 and 3 spare. Europe realized that Satellite navigation is an important satellite based service and started filing for spectrum in the mid nineties for Galileo. Galileo has 4 satellites and expects to reach to 22 satellites in the next 2-3 years. For a good global coverage 24 satellites in Medium Earth Orbit (MEO) are required. The Chinese followed suit and India started the GAGAN and IRNSS programs about the same time.

The L band spectrum for Radio Navigation Satellite Service (RNSS) is very crowded. The US, Russia, Europe, China have filed for Global Navigation Satellite System (GNSS) principally in the L band in the eighties and nineties. India also filed for required spectrum in the L and S-band(2483.5 to 2500 MHz). Now, internationally, we have 5 global filings - US, Russia, Europe, China and India, 4 GPS augmentation filings by US, Europe, Japan and India and 3 Regional filings- China, Japan and India. If all systems are up and operating in the next decade, we may have nearly 200 satellites in the GNSS arena. Filings made by any country have to be "Coordinated" with all the countries who file for spectrum in that band. This calls for bi-lateral and multi-lateral co-ordination for spectrum, under the ITU umbrella.

Most of the satellites in GNSS are in the Medium Earth Orbit (MEO), ie the satellite altitude is about 25,000 to 27,000 Km from the centre of the Earth. Co-ordination of spectrum in GNSS is of utmost importance as otherwise there would be harmful interference from transmissions of one system into another which is detrimental to the service to be provided. Hence, any person leading the SATNAV program of the country has to interact with other system operators on a regular and sustained manner.

Designing the Communication network needs a very careful approach

K Sampath Kumar,
Sci/Engr-SF (Retd)
ISTRAC/ISRO,
Department of Space
Bangalore

I have enjoyed my work thoroughly all through my carrier and I owe my gratitude to our Department, which has allowed us to freely express and execute. I was in communications department from the day one of my carrier and involved in all the launch/satellite missions and also in many projects including GAGAN and IRNSS. My sincere thanks go to Mr S K Shivakumar, then Director, ISTRAC for assigning me the roles to play in GPS Aided Geo Augmented Navigation (GAGAN) and Indian Regional Navigation Satellite System (IRNSS) projects. Also I shall be grateful to the ISRO/AAI team that was great, with real stalwarts like Mr S Pal, Mr Kibe, Mr P Soma, Mr K N S Rao, Mr Ganesan, Mr Ramalingam (AAI), Mr Saraswathi (AAI), Mr Khan (AAI) and many more, who has made the toughest jobs to look simple without relenting on any issues.

Data Communication Network

The communication network requirements differ from a launch mission to a satellite mission and to projects like GAGAN/ IRNSS. While the launch/satellite mission networks are mission critical, the GAGAN and IRNSS are linked to the safety of the passengers in air. The Data Communication Network of GAGAN and IRNSS projects play an important role of transporting the navigation and measurement data from all the reference stations spread across the country to the Control Centre and also several internal communication back bone for various purposes. Designing the communication network needs a very careful approach in understanding the requirements of the project, the available solutions, various communication interfaces and the standards followed in different countries involved in similar projects.

The data communication requirements of GAGAN and IRNSS projects are very stringent and are similar in many aspects, one defined by M/S Raytheon and the other one of our own. The requirements were classified into the following categories

- Functional Requirements: Data flow requirements received from the project
- Technical Requirements: Defines the bandwidth, interfaces, latency etc.,

- Operational Requirements: Availability, Alarm, Escalation matrix etc.,
- Performance Requirements: Bit Error Rate, Mean Down Time etc.,

Though many of the requirements were critical, the challenging parameters are the availability and reliability factors. The availability number is 99.999% (one hour failure in 11years and 5 months). Hence, we were bound to work more on redundancies in terms of

- Link Level Redundancy
- Equipment Level Redundancy
- Changeover strategies or fail safe mode

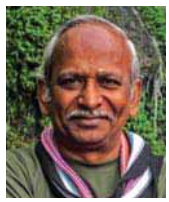
Two different transmission media were suggested for link level redundancy, 1) Optical fibre back bone and 2) Satellite based backbone. End to End optical fibre connectivity was suggested for all the nodes and to a greater extent that was achieved also with the help of service providers. In the satellite communication segment, the equipment redundancies were built up with auto changeover configuration.

Still, achieving the target was looking as a distant dream and so to meet the availability requirements multiple links were proposed between two given stations. Involving multiple links between two given stations has its own problem of selection and processing that was resolved by network team.

It was also ensured that there is no single point failure at any given point including the cable entry, the UPS (different UPS for different systems), Communication Earthing etc., and the special needs of a communication rooms were addressed.

For a communication network, establishing the network is the first phase and maintenance becomes the next phase that needs to be given highest priority and AAI is in right track in tackling the issues and the project will be yielding fruitful results soon.

Optimizing the Antenna (outdoor) and Receiver (indoor) distance to get maximum signal



Elango K
Former Deputy General Manager, NSA, & DPD, IRIMS-Ground Segment, ISTRAC/ISRO

I had a very nice experience during the last one decade while establishing the reference stations for navigational systems (both GAGAN & IRNSS) across the country as per the Project requirement. I have started my first site survey visit in 2003 for GAGAN at Thiruvananthapuram airport and my last visit was at Jodhpur, RRSC Campus in 2011 for IRNSS before my retirement. Here I am sharing my views on antenna and Station requirements only.

GAGAN Started with 8 Reference stations for Technology Demonstration System (TDS) and increased to 15 stations for the Final Operation Phase (FOP). 10 Stations were established during the phase-I of IRNSS and activities started for another 7 stations to meet the FOP requirement of 17 Reference Stations.

Site selection criteria/ site survey requirements

Outdoor requirement of Antenna location & Indoor requirement for accommodating receiver and other supporting equipment

The main requirements are as below:

1) Site Foundation for Antenna (Hard bedrock)
   - Radomes for environmental protection
   - Lightning Protection
   - Antenna Phase Centre measurements
   - Antenna height & horizon mask (Elevation profile-minimum 10 deg.)
   - Antenna phase centre measurements
2) Site security, Ownership and permission for long term
3) Multipath (away from reflecting surfaces)
4) Radio Frequency Interference of intended frequencies
5) Site infrastructure requirements & Continuous Power (UPS)
6) Proper earthing equipment, building etc.
7) Met. Sensor provision
8) Local data logging & Storage
9) Data communication to Control Centre

Optimisation

- Accommodating the Reference stations within Airport Authority of India (AAI) and Indian Space Research Organisation (ISRO)
- Existing buildings/Rooms were utilised where ever possible for indoor equipments – Wherever required, New constructions were also made
- Transportable containers were planned in few locations which can be re-located as per Project Requirement
- Coordination with WMO of DOT for RFI
- Few stations were re-located in view of RF interference for both GAGAN & IRNSS
- Planning suitable indoor equipment like Reference receiver and supporting units like communication etc.
- Receiver antennae were installed both on ground as well as on roof-top depending upon the site suitability
- Optimizing the Antenna (outdoor) & Receiver (indoor) distance to get maximum signal
- Periodical reviews on the sites - and suggestions were implemented

Torrent website to host networks on GPS-guided drones

The Pirate Bay (TPB), a bittorrent website, announced to take its networks off the earth's surface. It is considering launching a series of 'GPS-controlled drones, far-reaching cheap radio equipment and tiny new computers like the Raspberry Pi' to float the Low Orbit Server Stations (LOSS). Through this way, it aims to keep the website safe from law enforcement officials.

It also plans to test its hosting drone over international waters and said that any attempt to destroy the devices by aeroplane will be a "real act of war". *www.techweekeurope.co.uk*

GLONASS stations to be set up in 34 countries

Russia will set up GLONASS ground support stations in 34 countries across the globe, Russian Space Systems General Director and General Designer Yury Urlichich announced. Urlichich stated that the Russian Space Systems has all the necessary resources to install such stations in nearly 20 countries, which include Australia. *www.interfax.com*

UK lists solar storm as threat to national security

The UK government added volcanoes and solar storms to floods, flu and terrorism on a list of threats to national security. The highest-priority risks to Britain are pandemic influenza, coastal flooding, terrorist attacks and - a new addition - volcanic eruptions in countries like Iceland, according to the recently published 2012 edition of the government's National Risk Register for Civil Emergencies.

The storms can't hurt people, but can disturb electric grids, GPS systems and satellites. In 1989, a strong solar storm knocked out the power grid in Quebec, cutting electricity to 6 million people. Last week, the strongest solar storm since 2004 passed without major disruptions.

70% navigation devices in Chinese market are problematic

Over 70 percent of GPS navigation devices in the Chinese market failed to pass a recent sample inspection carried out by experts. Out of a total of 18 different GPS devices, produced by 13 major firms, only 5 devices produced by three different factories, have passed the inspection and are deemed fit for use. The pass rate was below 30 percent.

Among the 18 different types of device, 17 failed to locate a particular position, or were unable to find a path to a specified location. Some devices used outdated map data that was first published ten years ago. The amount of problems concerning GPS navigation devices was much greater than initially expected, especially in relation to data inaccuracy, said the panel's experts. *english.cri.cn*

First Indian navigation sat to be launched this year: President

First Indian navigation satellite will be launched this year, announced President Pratibha Patil, during the joint sitting of Parliament. The Indian Regional Navigation Satellite System (IRNSS) will be a constellation of seven satellites having all-weather, round-the-clock coverage over the Indian landmass with an extended coverage of about 1,500 km around it.

"Several major satellite launches are planned for 2012, including India's first microwave remote sensing satellite (RISAT-1) with all-weather imaging capability," President added. She said that the next flight of the Geosynchronous Satellite Launch Vehicle using the indigenous cryogenic upper stage was also proposed to be conducted this year. *economictimes.indiatimes.com*

Russia... GLONASS Spending Amiss?

Investigators have been brought in to look into alleged misuse of federal funding, following...

...a high-profile public row between the Russian space agency and a manufacturing subsidiary, *Izvestia* daily reported on Thursday. The Federal Space Agency (Roscosmos) has accused Russian Space Systems (RSS) of jacking up the costs of the *Glonass* global navigation system program and diverting cash "saved." The controversy came to a point where Russian Deputy Prime Minister *Dmitry Rogozin*, who oversees the defense industry, had to step in, ordering the two parties to stop throwing mud at each other in public, which he said could "seriously harm the Russian space industry." *RIA Novosti*

China develops GNSS-based earth crust monitoring system

China developed a system to monitor the movement of the earth's crust and predict earthquakes, according to an official of the China Earthquake Administration. The system, based-on GNSS, involves a network of 260 constant observing stations and 2,000 part-time observing stations with data-processing technology. It will also be used for weather forecasting and scientific research, among other purposes. The new network joins the US Plate Boundary Observation system and Japan's GEONE as the most advanced means of observing the movement of the earth's crust. *Source: english.cri.cn*

GNSS market to reach EUR 244 bn in 2020: GSA

According to data released by European GNSS Agency (GSA), the total market value of GNSS-enabled devices is expected to grow from EUR 133 billion to EUR 167 billion in 2012, and EUR 244 billion by 2020. According to the GSA, road and LBS will become the two market sectors with the highest revenue generated from 2010 to 2020, accounting for 56.4 percent and 42.8 percent of the total revenue during this period, respectively. The road segment includes personal navigation devices and in-vehicle systems, while the LBS segment includes GNSS-enabled mobile phones and services, the agency reported. *focustaiwan.tw*

PENTAX | GNSS G3100-R1

PRECISION SATELITE SURVEYING
WITH WIRELESS COMMUNICATIONS

Positioning systems

- **Single Rugged Lightweight** Housing
- **State of the Art** 136-channel AsteRx2 **Receiver** with GPS/GIONASS
- **Integrated Satellite Antenna** for Optimized Satellite Tracking
- **Base** or **Rover** Configuration
- **Multiple Communication Choices**
- **Hot Swap Batteries** with Fuel Gauges
- **Easy Removable SD Card** for Data Logging
- **Bluetooth Controller**
- **Rugged Field Controller** with Field Genius for Efficient Field Survey

TI Asahi Co., Ltd.
International Sales Department
Tel.: +81-48-793-0118
Fax. +81-48-793-0128
e-mail: international@tiasahi.com
www.pentaxsurveying.com/en/

Pentax Distributor for INDIA
LAWRENCE & MAYO PVT. LTD.
274, Dr. Dadabhai Naoroji Rd.
Mumbai 400 001, INDIA
tel: +91 22 22 07 7440
fax: +91 22 22 07 0048
instmum@lawrenceandmayo.co.in
www.lawrenceandmayo.co.in

Brazilian school uniforms get RFID power

Brazilian city of Vitoria da Conquista made mandatory to wear radio frequency sensor (RFID) embedded uniforms to school students. Such uniforms send alerts to parents if their children bunk classes. In total, city officials have spent USD 670,000 to design, test and manufacture the high-tech uniform. *Associated Press www.google.com*

EU funds 'i-Going' project to enhance indoor navigation

The European Union (EU) funded 'i-GOing' project, which aims to design, develop and demonstrate a precise indoor navigation service based on Galileo and advanced 'pseudolite' technologies. Pseudolites are small transceivers that are used to create a local, ground-based GNSS alternative. With the help of pseudolites, users will be able to locate themselves using GPS and Galileo signals, and then continue to receive accurate location signals in a seamless transition while moving into a building equipped with pseudolites. Better than one meter accuracy will boost new indoor applications allowing users, for instance, to reach departure gates more quickly and efficiently, reducing the significant cost consequences of the notorious 'lost passenger'. *www.gsa.europa.eu*

Real time tracking of Indian trains

The Centre for Railway Information Systems (CRIS), the technology arm of the Indian Railways, developed a GPS-based solution with help of Indian Space Research Organization (ISRO), which can provide exact location of trains with an accuracy of 10 metres, and latency of 2 minutes, on a real-time basis. ISRO's INSAT-3C satellite will help in determining the location of these moving trains. The GPS devices, which will cost around INR 70,000-1,00,000 per train, would be fitted in about 100 trains, which may help avert collisions and prevent loss of lives. Indian Railways has about 77 control offices at over 6,000 stations. A pilot project has already started between Chennai and Tambaram railway stations, where about 364 suburban train services have been scheduled successfully with the GPS devices. *articles.economictimes.indiatimes.com*

GPS Intelligence launches CDMA PRO fleet tracker

GPS Intelligence, a leading provider of GPS tracking systems for commercial and government applications in USA, has released the all new CDMA PRO, a GPS-based fleet tracking device that provides superior tracking capabilities for fleet tracking and mobile workforce management. Operating on the Verizon cellular network, the it provides consistent, highly accurate location data for vehicle tracking. It offers fleet managers a cost-effective system to improve dispatching and overall fleet efficiency. *www.prweb.com*

S Korean telecom companies misuse location data'

Subcontractors of two South Korean mobile carriers sold location information of 200,000 customers, reported a Korean daily. With this report, the daily observed that this theft highlighted a deep hole in the protection of location information, and is a grave infringement of the privacy of subscribers. The daily warned that misuse of LBS is on rise in the country. With more and more people embracing this technology, the potential for exploiting this service has also increased at an alarming rate. *www.koreatimes.co.kr*

GPS and LBS markets on the rise in India

As the recent market reports predict that the worldwide GPS market is expected to reach USD 26.67 billion by 2016 at a CAGR of 23.7 percent from 2011 to 2016. And, global market for location-based services is set to touch EUR 300 mn in 2016. India too, holds tremendous potential in these markets and has geared up to cash it, observes Indian media. Recently, Tata DOCOMO, the unified telecom brand of Tata Teleservices Limited, launched 'Offers Near Me', a unique location-based advertising service for its GSM customers in Andhra Pradesh state. 'Offers Near Me' is a LBS that allows Tata DOCOMO GSM customers to receive exciting deals, offers and discount coupons from their favorite retailers—FMCG brands, apparel companies, malls, restaurants, cinemas, coffee shops, auto dealers, and many more. *www.business-standard.com*

FBI shuts down GPS trackers

A recent ruling on GPS tracking prompted the US Federal Bureau of Investigation (FBI) to turn off about 3,000 tracking devices, according to FBI General Counsel Andrew Weissmann. The Supreme Court ruling on US v. Jones, which found that placing a GPS tracker without a warrant constituted an illegal search, has apparently caused a "sea change" in the Bureau, leading it to draft broader guidelines for both GPS device use and related questions regarding the right to privacy. Although the ruling doesn't necessarily apply to things like cell phone location tracking or collecting information from other third parties. *www.theverge.com*

Real-time surveillance bill by Mexico legislature

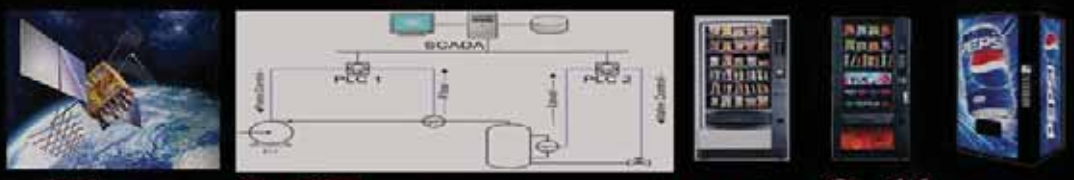
The Mexican legislature unanimously passed a surveillance legislation that will grant the police warrantless access to real time user location data. Under this new law police with be able to access citizen's data in real time without their knowledge. The bill has been sent to Mexican President for final approval. Privacy and electronic communications experts have characterized the bill as being against the human rights of the individuals being monitored. *www.eff.org*

u-blox' CellLocateTM technology

u-blox has provided their CellLocate™ hybrid GPS/cellular positioning technology to LOSTnFOUND, a Swiss based company specializing in intelligent solutions for the protection, monitoring and retrieval of people and property. *www.u-blox.com/en/celllocate.html*

WWW.TRACE.ME

Never lose control with this innovative little piece of GPS/GPRS hardware.



TraceME can protect, follow and control most of your valuables.

Hardware dimensions of the smallest version: 44 x 22 x 7mm
Extremely small and lightweight including housing, antennas and battery.

TraceME applications: Personal tracking with SOS. Object protection and tracking. Logistics. M2M. Security and Surveillance. Remote control and Diagnostics. ODB-II version available. Vehicle immobilisation. Rentals tracking. Alternative and cheaper solution for SCADA. Alzheimer-, eldery-, patients- and people tracking. Remote control of Vending- and other machines in the field. Animal tracking. Backup Power Generators. OEM version is possible.

UNCS to develop multi-scale geospatial datasets

The UN Cartographic Section (UNCS) is planning to develop global multi-scale geospatial datasets (or UNmap) for rapid map production and web mapping in support to the Security Council and the Secretariat including UN field missions. Currently, an interim version of UNmap in scales of 1:1 million, 1:5 million and 1:10 million are in the final stages of completion. These maps are being used as primary geo-databases for UNCS and UN field missions. The purpose of UNmap is to develop and maintain a spatial data infrastructure (integrated with the datasets of UN international boundaries and SALB as well as UN Gazetteer) for UN needs that will provide a single homogeneous dataset of global geospatial features of the world for any mapping purpose. *ggim.un.org*

US agriculture department eyes cloud for geospatial data

The Agriculture Department's Farm Service Agency (FSA), US, is considering using cloud-based web services to access geospatial data and imagery. The FSA is seeking ideas on how to use commercially available web-based services to provide a base layer for its geospatial information systems. As part of its IT modernisation programme, the FSA uses a thin-client model that leverages web services to access geospatial aerial imagery of farm boundaries that personnel use for farm-related programmes. *www.informationweek.com*

China maps SCS to reinforce territorial claims

China may step up its exploration of South China Sea to reinforce its territorial claims following announcement that geographical surveys of the area are underway. "By drawing a map, the country can reinforce its jurisdiction claim in the South China Sea, and further actions may follow, such as exploiting resources near the Nansha Islands.", said Zhang Yunling, Director of the Institute for International Studies under the Chinese Academy of Social Sciences. According to a report released by China's National Administration of Surveying, Mapping and Geo-information (NASMG) a working group jointly set up by 13 government agencies will continue geographical surveying of the South China Sea and draw a map of the sea or its islands to "declare China's stance" on territorial issues. *news.oneindia.in*

The Strauss Center uses Esri technology

The Strauss Center's Climate Change and African Political Stability (CCAPS) program has implemented Esri technology to view how climate change impacts vulnerable populations in Africa. CCAPS created the dynamic mapping tool in partnership with AidData for use by researchers, policy makers, journalists, and citizens. Users can visualize any combination of CCAPS data on climate change, conflict, and aid on a map to discover how different forces overlap or intersect. The tool is already being used in the country of Malawi for a solution that tracks and reports on the country's external funding. *esri.com/news*

Sites are bypassing Google maps

Websites that used to incorporate Google Maps into their own pages are considering other options, claiming the search giant is charging hefty licensing fees (sometimes run into six figures), according to a report published in The New York Times. Now they are embracing OpenStreetMap (OSM), a user-contributed map service. In October 2011, Google had announced that it would start charging fee from smaller sites that generated more than 25,000 map views each day over 90 days. *www.nytimes.com*

India uses satellite images to keep land records

Under the national land records modernisation programme, the Rajasthan state government in India initiated a land mapping project, using Electronic Total Station (ETS), aerial photographs and high resolution satellite images. Once the project is fully implemented, every data of the agriculture land will be digitised and made available online. Officials claim that once everything will be on public domain, the land scams and irregularities will reduce to a great extent. *timesofindia.indiatimes.com*

GIS-based water network monitoring service in Portugal

Aguas de Cascais (AdC), a water utility body in Cascais, Portugal, selected a GIS-based water network monitoring service provided by Israeli company TaKaDu. AdC is the first water utility in Portugal to adopt such a solution. This web-based service allows the water utility body to detect leakage and network problems as they occur. The TaKaDu service analyses data received from existing meters and sensors already installed in the AdC network, and identifies inefficiencies or faults before they escalate. *www.takadu.com*

Bhutan to update topo map

With technical and financial aid from Thailand, using GIS and remote sensing technology, the National Environment Commission (NEC) of Bhutan commissioned a project to update topographic mapping of the country. As part of this three-year project, Bhutan will have satellite imagery of every dzongkhag (an administrative and judicial district of Bhutan) by the end of 2012. The imagery will help authorities to assess the status of development works. The Thai government will fund about USD 9 million. In addition, a team of six experts from Thailand will train NEC officials on using GNSS, remote sensing and GIS. *www.kuenselonline.com*

USD 10 mn for Tajikistan cadastre

The World Bank (WB) announced USD 10 million fund as an aid to Tajikistan to support the projects of registering farmland and increasing energy conservation. The WB funding will help in expanding the restructuring of farmland holdings. It will also enable officials to give farmers certificates entitling them to use land, further development of the cadastre system and aid the formulation of various pilot projects for registering real estate. Completion of the agricultural project is scheduled for March 2015. *centralasiaonline.com*

HEXAGON 2012
THINK *FORWARD*

4-7 JUNE 2012
LAS VEGAS, NEVADA, USA

THINK *OPPORTUNITIES*

Join Leica Geosystems in Las Vegas, NV, 4-7 June for targeted sessions and workshops, visionary keynote presentations, interactive technology demonstrations, unlimited networking and much more! Think forward with Hexagon and learn how you can begin solving tomorrow's problems today.

For the latest Hexagon 2012 updates, follow us on **Facebook**, **Twitter**, **Google+** and **LinkedIn**.

REGISTER *NOW! Visit* ***www.hexagonconference.com/geo***

- when it has to be **right**

Leica Geosystems

See us on

RapidEye imagery contributes to African Malaria Control Project

Rapid Eye imagery is being used by the MALAREO project to assist with malaria control programs in countries in southern Africa. While mosquitoes can obviously not be observed via satellite, their habitats, which are considered malaria risk areas, can be. The MALAREO project, funded by the European Commission under FP7, is a mixed European-African consortium which incorporates years of experience in malaria control with the Global Monitoring for Environment and Security (GMES) EO capacity. Approximately 25,000 square kilometers of RapidEye data was provided via the EC/ESA GMES Space Component Data Access (GSC-DA) covering the MALAREO study area in South Africa, Swaziland and Mozambique. *www.rapideye.net*

Kiran Kumar is new SAC, India Director

A S Kiran Kumar, Associate Director, Space Applications Centre (SAC), Ahmedabad, took over as its Director on March 31, 2012. He succeeds R R Navalgund. The SAC is an important facility under the Indian Space Research Organisation (ISRO). It specializes in designing and developing payloads for various Indian satellites, including the Chandrayaan missions.

Mr. Kumar joined SAC/ISRO in 1975 and contributed to the design and development of electro-optical imaging sensors for satellites in low-earth and geo-stationary orbits, starting from the television payload on the Bhaskara satellites to the latest terrain mapping camera and hyper-spectral imager payloads for the Chandrayaan-1 mission. He played an important role in the development of sensors and the technology needed in satellites for land, ocean, atmospheric and planetary studies. *http://www.thehindu.com*

Vietnam selects SPACEBEL for EO satellite

Vietnam Academy of Science and Technology (VAST) signed contractual pre-agreements with the Belgium-based SPACEBEL, a software engineering company operating in the space and earth monitoring applications sectors, for the supply of an earth observation mini-satellite, VNREDSat-1b (Vietnam Natural Resources, Environment & Disaster Monitoring satellite). The satellite is scheduled to be launched in 2017. *www.spacebel.be*

China needs its own space law

China needs its own space law to protect its rights in outer space as well as to regulate its domestic space activities, according to Hu Hao, Deputy Commander-in-Chief of the lunar exploration centre under the Commission of Science, Technology and Industry of National Defence (COSTIND), China. Hu, also a deputy to parliament, the National People's Congress, said this during the ongoing annual legislative session.

A space law could help ensure China's implementation of the four international conventions that it has joined since becoming a member of the United Nations Committee on the Peaceful Uses of Outer Space, as well as solve legal issues amid China's increasing space cooperations with other countries. China currently has few separate regulations on space activities, which are unable to meet the rising demands of space development, stated Hu. *http://english.peopledaily.com.cn*

SimActive unveils New Dense DSM Technology

SimActive Inc has released 4.0 of its Correlator3D™ product capable of producing dense digital surface models (DSM). This next generation GPU-enabled technology delivers close to three times more points compared to previous releases. Along with very high point density, it features powerful new enhancements for better representation of terrain topography. *www.simactive.com*

PCI Geomatics releases GXL aerial v2.1

PCI Geomatics released GeoImaging Accelerator Aerial (GXL-Aerial) version 2.1. PCI has made numerous improvements to the GXL including increases in accuracy and speed, advanced automation, and an enhanced user experience. GXL Aerial v2.1 also adds support for the DMC camera format providing wider usability and flexibility. *www.pcigeomatics.com*

Images indicate deforestation in India

The National Tiger Conservation Authority (NTCA), India, revealed in its report that the forest fire destroyed over 3,500 hectare area (ha) of Nagarhole and 2,000 ha of Bandipur tiger reserve in the country.

The report titled 'A rapid assessment of recent forest fires in Nagarhole and Bandipur tiger reserves,' cited information gathered from various local sources about the locations and extent of forest patch burnt and active fires detected by MODIS sensor onboard TERRA and AQUA satellites of NASA (corrected for park boundary delineation errors) as well as an examination of RESOURCESAT satellite images available from the National Remote Sensing Centre (NRSC). *www.deccanherald.com*

Astrium's PixAgri service helps Canada in crop management

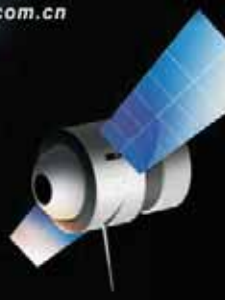
Astrium Services' PixAgri satellite imaging service for crop management completed its first agricultural campaign for "La Coop federee", the largest agrifood business in Quebec, Canada. PixAgri has been developed by Astrium Services to help farmers optimise the management and yield of their crops. Working from satellite images, the geo-experts from Astrium in Toulouse provide Canadian producers with information that can detect crop anomalies including drainage faults, excessive leaf growth or seeding problems, in order to improve the quality of their crops and their yield. The system offers a capability to manage farmland thousands acres wide. *www.eads.com*

FOIF

It's professional
Since 1958

Suzhou FOIF Co.,Ltd.

For more information please visit our website:
www.foif.com.cn
or email to: *internationalsales@foif.com.cn*



F50 GNSS/GIS Handhelds

* Equipped with static and RTK GNSS engines
* GPS+GLONASS satellites tracking capability
* High-performance sub-meter GNSS/GIS handhelds,
  RTK collection accuracy with internal antenna: 1cm+1ppm
* Supports external antenna for high precision RTK or static measurement
* Rugged design, MIL-STD-810G and IP67 compliance,
  -30℃ to +65℃ operating temperature
* Internal 3.5G WWAN modem(HSDPA/
  WCDMA/EDGE/GPRS/GSM)

RTK Accuracy:
2cm+1ppm/internal antenna
1cm+1ppm/external antenna
Static Accuracy:
3mm+1ppm/external antenna

JANAK

Please contact with FOIF Dealer in India
JANAK POSITIONING&SURVEYING SYSTEMS PVT.,LTD
E-mail:janakji@vsnl.com Website: www.janaksurvey.com
Tel: 011-23515400,23515399 Fax: 011-23682185

TÜV CE ISO-9001 DNV

Hemisphere GPS' new miniEclipse™ Compact OEM Modules

Hemisphere GPS Eclipse™ P300 and Eclipse P301 OEM modules is the next generation high performance compact modules for RTK GNSS applications. P300 is a drop-in board replacement for Hemisphere GPS' successful Crescent® L1 board as well as the first generation miniEclipse P200 GPS-only OEM board. P301 is the 20 pin OEM module configured as a drop-in replacement for a different industry standard interface. Eclipse P300 and P301 improve GNSS positioning performance, particularly with RTK applications, through Hemisphere GPS' patent-pending SureTrack® technology. *www.hemispheregps.com*

ITT Exelis bags USD 32 mn contract from Lockheed

Lockheed Martin awarded a USD 32 million contract to ITT Exelis to build the navigation payloads for the GPS III space vehicles three and four. Exelis announced in December 2011 that it had successfully integrated and performed the initial power up of the full-size payload prototype known as GPS III Non-Flight Satellite Testbed (GNST) Navigation Payload Element. Scheduled for first launch in 2014, GPS III satellites will deliver significant improvements compared with current GPS space vehicles. *www.exelisinc.com*

GNSS post-mission compatibility with Survey/GIS software

Effigis has launched a new version of its OnPOZ-EZSurv GNSS post-processing software (V2.89), introducing advanced compatibility with industry-standard field survey and GIS data collection software. It includes full compatibility with MicroSurvey FieldGeniusand Carlson SurvCE survey software and with ESRI ArcPad GIS software. With this compatibility, the user can replay any field data collection in post-mission (kinematic or static) to fill RTK gaps and apply rigorous QA analysis to survey data.

GNSS chip from Broadcom for indoor positioning

Broadcom Corporation has introduced a new location architecture and a GNSS chip to provide more responsive outdoor and indoor positioning capabilities for smartphone devices for applications, such as indoor positioning and place-based mobile commerce. The new chip reduces time-to-first-fix (TTFF) for outdoor positioning applications, cutting the time smartphone users have to wait when first checking their position. *www.eeherald.com*

GPS accuracy verification technique

SpeedGauge has announced a new GPS data accuracy and quality verification technique - SpeedGaugeAssurance, which assists telematics service providers to unobtrusively monitor the accuracy of infield devices and to benchmark the performance of devices in real-world operating conditions. *SpeedGauge*

GPS/GLONASS module for navigation devices

Telit Wireless Solutions has announced a new dual GPS/GLONASS module that dramatically improves navigation performance by providing access to both the Russian GLONASS global navigation satellite system and U.S. GPS. Its new Jupiter(R) SL869 provides three times the usual satellite visibility by accessing to up to 22 satellites. It further reduces the delay from several minutes to seconds for a navigation device to acquire its position after being powered on. *www.telit.com*

FARO releases 3D scan processing software SCENE 5.0

FARO Technologies SCENE 5.0 is the latest in the company's line of point cloud capture processing software for the Focus3D. It contains automatic fine registration, a new cloud-to-cloud enhancement that reduces or removes the need for the placement of artificial targets in many scanning applications, and significantly reduces post-processing time. Rather than utilising spheres or checkerboards, the software identifies prominent objects such as corners, edges and other flat structures within the scan and uses them as reference points. *www.faro.com*

New Versions of POS AV and POSTrack Systems by Applanix

Applanix has introduced its latest generation of GNSS-inertial and flight management systems (FMS) for airborne mapping—the POS AV™ V6 and POSTrack™ V6.

Leica Spider Software Suite v 4.2

Leica Geosystems new version 4.2 of its Spider software suite is globally used solution for GNSS RTK networks is being continually enhanced and developed following the market needs and technological development to the benefits of its users. It is an integrated suite of programs for GNSS networks, consisting of Leica GNSS Spider, Leica SpiderWeb and Leica SpiderQC. *www.leica-geosystems.com/nrs*

Leica iCON

Leica Geosystems iCON is a pioneering portfolio of tailor-made positioning and measuring solutions for construction professionals. It changes the way construction tasks are performed on site by offering new technology that significantly optimizes construction workflow efficiency enabling contractors to enhance their performance and increase their profitability through perfecting the entire construction workflow.

Leica MissionPro

Leica Geosystems Geospatial Solutions Division released of its new mission planning software, Leica MissionPro. It provides mission planning capability for all airborne sensors including LiDAR, line and frame sensors and is fully integrated into existing Z/I Imaging and Leica Geosystems workflows. *www.leica-geosystems.com/missionpro*

Knowing to

Manage the territory
Protect the environment
Evaluate the cultural heritage

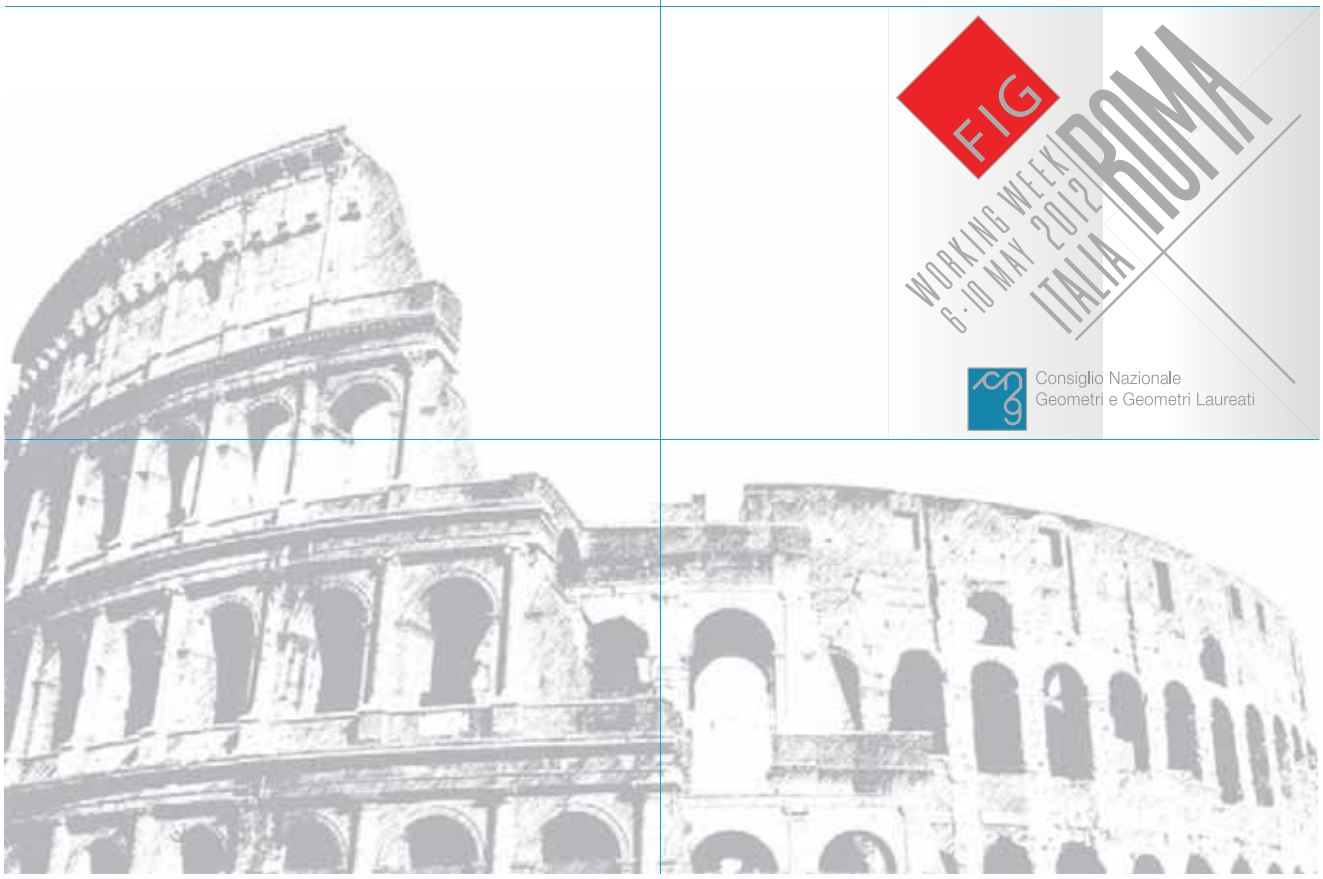


FIG WORKING WEEK 6-10 MAY 2012 ITALIA ROMA

Consiglio Nazionale
Geometri e Geometri Laureati

FIG Working Week 2012

Rome, Italy 6–10 May 2012

www.fig.net/fig2012

April 2012

The Seventh National GIS Symposium in Saudi Arabia
29 April – 1 May
Dammam, Saudi Arabia
www.saudigis.org

May 2012

FIG Working Week 2012
6-10 May
Rome, Italy
www.fig.net

2nd International conference and exhibition on mapping and spatial information (ICMSI2012)
7-9 May
Tehran, Iran
http://conf.ncc.org.ir

Global Geospatial Joint Conference 2012
14-17 May
Quebee City, Canada
www.gsdi.org/gsdiconf/gsdi13

Geospatial Intelligence Middle East
15 - 18, May
Abu Dhabi, United Arab Emirates
www.geospatialdefence.com

6th GNSS Vulnerabilities and Solutions Conference
21-24 May
Baska, Croatia
www.rin.org.uk

MundoGEO#Connect 2012
29-31 May Sao Paulo, Brazil
http://mundogeoconnect.com/2012/en/

The 3rd China Satellite Navigation Conference
15-19 May 2012
Guangzhou, China
www.beidou.org

June 2012

Hexagon 2012
4-7 June
Las Vegas, USA
www.hexagonconference.com

The International Summer School on Mobile Mapping Technology 2012
11 – 15 June
Tainan, Taiwan
http://conf.ncku.edu.tw/mmt2013/intro01.htm

New Navigator Seminar 2012
14 June
The University of Nottingham, UK
http://rin.org.uk/events

20th International Conference on GeoInformatics
15-17 June
Hong Kong
http://old.nabble.com

Geospatial EXPO 2012
21-23 June
Yokohama, JAPAN
www.g-expo.jp/en/

July 2012

COM.Geo 2012
1-3 July
Washington DC, USA
www.com-geo.org/conferences/2012/index.htm

2012 Brisbane International Geospatial Forum
8 - 11 July 2012
Queensland, Brisbane, Australia
www.imtamaps.org/events/

ESA – International Summer School on Global Satellite Navigation Systems
16 – 26 July
Toulouse, France
www.munich-satellite-navigation-summerschool.org

Exploration and Mapping in Mining
17 - 19 July
Perth, Australia
www.explorationinmining.com

Survey Summit
21–24 July
San Diego, USA
www.surveysummit.com/index.html

ESRI International User Conference 2012
23-27 July
San Diego, USA
www.esri.com

August 2012

The XXII Congress of the ISPRS
25 August-1 September
Melbourne, Australia
www.isprs.org

September 2012

ION GNSS 2012
September 17-21, 2012
Nashville, Tennessee, USA
www.ion.org

October 2012

INTERGEO 2012
9-11 October
Hanover, Germany
www.intergeo.de/en

November 2012

Trimble Dimensions User Conference
November 5-7
Las Vegas, USA
http://www.trimbledimensions.com/

2012 International Conference on Indoor Positioning and Indoor Navigation (IPIN)
13-15 November
Sydney, Australia
www.surveying.unsw.edu.au/ipin2012

POS AV is a hardware and software system specifically designed for directly georeferencing airborne sensor data. POSTrack consists of the POS AV system with a tightly integrated advanced FMS, which provides mission planning, pilot guidance and sensor control.

GeoEye wins contract from GE Aviation

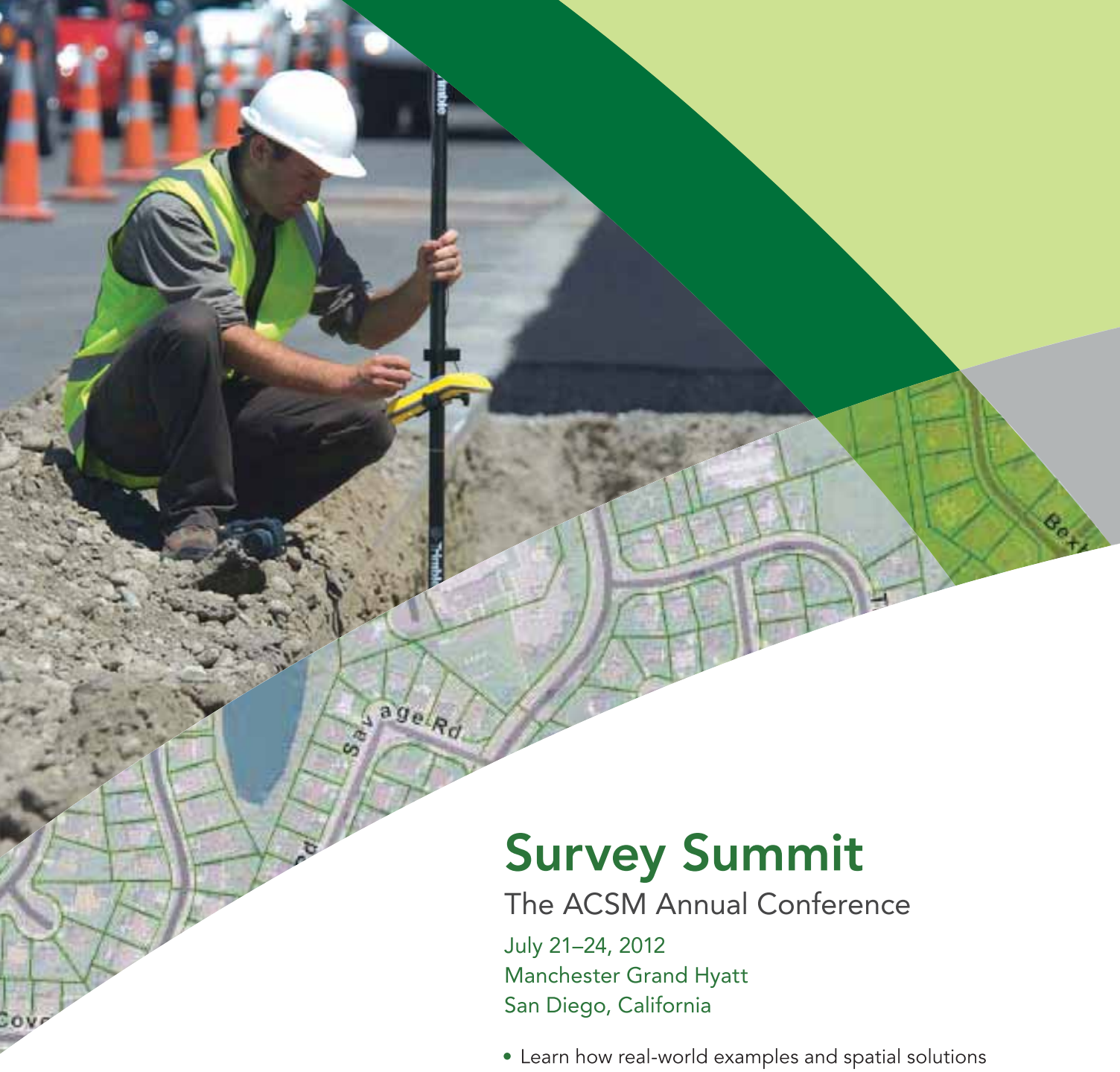
GeoEye, Inc. has received a multi-year, multi-million dollar contract from GE Aviation. Under this contract, it will produce aviation reference data to serve hundreds of the world's busiest airports. Over the next decade, GeoEye intends to capture all of the world's International Air Transport Association (IATA) airports. This agreement allows GE Aviation to utilize GeoEye 3D Airports and Terrain/Obstacle databases produced from GeoEye's stereo satellite imagery. These GeoEye aeronautical databases will be imbedded into GE Aviation's products and services.

Navigation equipment production facility in India

M2M Telematics is planning to build a navigation equipment production facility in India, announced the company's Executive Director Alexei Smyatskikh. Production is likely to be based on NIS GLONASS, the Indian subsidiary of Navigation and Information Systems (NIS GLONASS. "The Indian market is quite specific and the chief requirement is a low price for the equipment. That is why, in order to avoid additional expenses, NIS GLONASS has decided to organise production locally", Smyatskikh said. *indrus.in*

v.6 GeoPDF® software by TerraGo®

TerraGo® Technologies has released v.6 of its ComposerTM and ToolbarTM geospatial collaboration software. The new software creates GeoPDF® applications that are automatically enabled for dynamic updates and sharing by anyone, anywhere using TerraGo Toolbar and Adobe Reader®.



Survey Summit

The ACSM Annual Conference

July 21–24, 2012
Manchester Grand Hyatt
San Diego, California

- Learn how real-world examples and spatial solutions can improve your business.
- Connect with your peers to share ideas and explore industry developments.
- Bridge the gap between emerging technologies and new business practices.

To register for the Survey Summit or to exhibit, go to **surveysummit.com**

ACSM

esri®

Doresa with her Dad

Drawing 'the difference'

Meet Doresa Demaj. She is an eleven year old girl from class 6B at the Theodor-Storm-School in Berlin. She loves reading and swimming. She also loves drawing and painting. Have a look at her drawing printed above. Interesting! Is n't it? It is about space, rockets, astronauts,…The choice of colors, which goes so well with the theme.

Last autumn, Ms Gruner, the teacher in charge of class B suggested her students to participate in Galileo Drawing Competition. Doresa participated in this competition and won the 1st prize in Germany. She received her trophy (a model of the satellite which will be named after her) and a certificate from Dr Reinhold Ewald, a German astronaut working for the European Space Agency (ESA) and a member of the Galileo jury in Germany at the award ceremony of the Galileo Drawing Competition on 14 February 2012.

The jury was fascinated by her picture and why not. She used many different techniques. She started with drawing, used painting colors and glued different bits and pieces to her picture. The winning picture is a mixture of a collage, a painting and a drawing. Wolfgang Tiefensee (former German Transport Minister, Member of the Galileo Jury) observed, "The selection of colors is incredibly interesting, as the picture has all the different colors we would associate with the topic of "space/aeronautics": different shades of blue, yellow and white."

I met Doresa last month when she came to Munich Satellite Navigation Summit 2012, with both the painting and trophy to say a few words on space and satellite navigation. While Doresa was presenting her drawing at the Summit, I was thinking - it is not about a drawing or about a child. It is also not about a drawing competition. It is more about generating awareness and engaging children on the issues which are otherwise confined to the elite walls of some elite groups. Galileo Drawing Completion takes the lead. Will other follow?

The Galileo Drawing Competition took place in each of the 27 European Union Member States throughout 2011. Children born between 2000 and 2012 in each of these countries were encouraged to take part. Each child was required to submit a piece of artwork based on the theme "Space and Aeronautics". The children were invited to give free rein to their imagination and use any drawing, painting and coloring material and techniques they wished. Pictures were then scanned or photographed and uploaded to the competition website (http://www.galileocontest.eu/). The winners have now been selected and the name of each individual child will be given to a Galileo Program Satellite. The competition in Germany ran from 1st September to the 15th November 2011.

- Bal Krishna (with inputs from Eszter Kiss and Heike Haas)
bal@mycoordinates.org

KTS-470RC series

Windows Total Station

New Model

KTS-470RC Series

- Windows CE 4.2 Standard System
- SD Card Data Storage (Maximum 4G)
- Dual Axis Compensation
- Mini USB Port for Communication
- Built-in Laser Plummet (Optional)
- 350m Reflectorless Range

Win CE Operating System,Touch Screen

SD Card, Mini USB Connection

Built-in Software, Dual Compensation

Surveying program interface

KOLIDA
www.kolidainstrument.com

GUANGDONG KOLIDA INSTRUMENT CO.,LTD.
ADD: 2/F, Surveying & Mapping Building (He Tian Building),
NO.24-26, Ke Yun Road, Guangzhou 510665, China
TEL: +86-20-85542075 FAX: +86-20-85542136
Email:export@kolidainstrument.com

INDIAN ENGINEERING AGENCIES
ADD: #6, State Bank ST., Mount Road,
Chennal 600002, India
TEL: +91-44-28601987
FAX: +91-44-28607611

SIMPLY. AMAZING.

COMPACT, DUAL FREQUENCY BOARD

When power consumption, size and dependable performance such as raw data quality and/or real-time positioning are critical, the Ashtech MB 100 GNSS board simply delivers! It features internal heading and Z-Blade™ Technology for amazing long-range dual frequency RTK performance or dependable L1 GPS+GLONASS+SBAS positioning.

SKYNAV® GG12W™ GPS+SBAS BOARD

The SkyNav GG12W is ideally suited for integration within Technical Standard Order (TSO) Flight Management Systems (FMS), ground-based reference stations for GPS aircraft landing systems (SCAT I and LAAS) and other avionics. In addition to traditional GPS receiver design and ISO 9001 engineering practices, the SkyNav GG12W adheres to all FAA/RTCA design criteria.

RUGGED AND COMPACT GNSS SYSTEM

The HDS800 is a rugged dual board GNSS system that delivers state-of-the-art RTK accuracy, including heading and relative positioning. Designed for seamless onboard system integration, it is available in a variety of configurations. Embedded Z-Blade™ technology ensures powerful RTK performance and a patented way to use multiple GNSS constellations for high-accuracy positioning and surveying solutions.

MULTI-CONSTELLATION, MULTI-FREQUENCY BOARD

With the new MB 800 multi-constellation board, Ashtech brings to the OEM market a unique blend of technologies which increases RTK availability and data integrity. Embedded Z-Blade™ technology ensures powerful performance and a patented way to use multiple GNSS constellations for high accuracy positioning, and surveying solutions.

Z-Blade

Ashtech's Z-Blade™ Technology is a unique patented method using multiple GNSS constellations for high-accuracy positioning. Z-Blade technology secures the best possible measurements from the GPS, GLONASS and SBAS constellations and mixes multiple observables with no compromise between quality and availability. This leads to an incredibly robust and dependable measurement processing resulting in optimized productivity.

- New Ashtech GNSS centric signal processing:
  Fully independent GNSS satellites tracking and processing
- Fully independent code and phase measurements
- Ability to work in GLONASS-Only mode
- Outstanding reliability in urban canyons and under tree canopy
- Multi-frequency and multiconstellation ready
- Advanced multi-path mitigation

ashtech™
A TRIMBLE COMPANY

www.ashtech.com
oemsales@ashtech.com

Introducing the NEW SXPad

SXPad

"The SXPad is the simplest, most powerful and cost-effective solution for your mobile GIS application challenges."

- Incredible 3.7" VGA outdoor screen
- Built-in Wifi and GSM/GPRS cellular modem
- Built-in GPS, Bluetooth and 3MP Camera
- Windows Mobile 6.5 Pro
- Rugged, Waterproof, Lightweight
- Very affordable

SXBlue GPS Series

WWW.SXBLUEGPS.COM

GENEQ inc.
10700, Secant St. | Montreal (Qc) Canada H1J 1S5
Tel.: 514 354-2511 / 1 800 463-4363 | info@geneq.com

SXBlue GPS

Introducing our new easier-to-hide OEM6.

The new OEM615 GNSS receiver from NovAtel provides the industry's leading GPS+GLONASS dual frequency RTK positioning performance – in our smallest form factor – so you get all of NovAtel's reliability but in a more discreet, easy-to-integrate card. For more info, visit novatel.com/oem6 or call you-know-who. **Integrate success into your [redacted].**

NovAtel