

# Coordinates

Volume IV, Issue 8, August 2008

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

Survey and GIS

## Finding the missing link



Also:

- Galileo E5 signal acquisition strategies
- Classifying pedestrian behaviour
- The success of NSDI lies in innovative applications

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## The dragon is moving faster

China is set to prove its determination for rapid development.

Olympic is not the sole reason but is otherwise also.

It seems to be backed by a vision and action plans.

One one hand we can see the massive infrastructure developments in cities like Beijing and Shanghai.

On the other hand, the country managed the recent disaster with better planning and preparedness.

The ISPRS conference in Beijing this month displayed the linkages between development and technology.

Applications of the technology in various aspects of development.

Also, the applications of geomatics technology in disaster management was very much was evident.

Especially in rescue and response efforts after the Wenchuan earthquake.

Around 53,000 maps and 11 terabytes of geographic information were provided.

An emerging model of development.

A model that seems to encompass the elements of disaster management.

Surely to admire.

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# Surveying and GIS: Finding the missing link

There still needs to be more dialogue between the GIS industry and the surveying profession so that each group better understands how cooperation can benefit all parties

" A big challenge is integrating the surveying profession with the GIS profession. There's a growing tension between them. One of the bridges that I want to accomplish this year is integrating the technology so the surveyors can have tools within the GIS toolbox that allows it to create and manage surveys that can be directly used by the GIS people. The GIS datasets, in turn, can be refined based on survey information, especially transaction based survey. These two goals are separate and sometimes they run into a big conflict about who should do what. I think I would be technically directing them and say these technologies can be synergist. There is a need to search out surveyors that want to grow their activities in the GIS areas and search out GIS people who want to have a strong survey inclination."

Jack Dangermond  
President, ESRI  
Coordinates, Volume 3  
Issue 3, March 2007

*When Jack made the above statement we found ourselves wondering what other experts, from both sides of the stated divide, felt about the matter. We set ourselves the task to find out. We published a story last year in June ([www.mycoordinates.org/surveying2007.php](http://www.mycoordinates.org/surveying2007.php)).*

*After a year, we again raised the same topic and sought the opinion of some of the experts.*



**Gary A Jeffress, PhD, RPLS**  
Professor of Geographic Information Science  
Director of the Conrad Blucher Institute for Surveying and Science at

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## The Value of Land Surveyors

Ten years ago the California Board for Professional Engineers and Land Surveyors (BPELS) attempted to pass a set of rules that required all digital mapping to be performed by Professional Land Surveyors. The motivation for these rules stemmed from the definition of surveying under the California Professional Land Surveyors' Act, which includes specific reference to digital mapping being within the purview of the Professional Land Surveyor. The BPELS at the time concluded that there were sufficient risks in the making of digital maps, which if made incorrectly, could cause damage to the health and welfare of the public.

The BPELS is made up of 13 members. Seven of these are public members (having no professional background in Engineering or Surveying), five are licensed Professional Engineers, and one is a licensed Professional Land Surveyor. The following history of the BPELS appears on their web site:

## A Brief History of the Board

The California Legislature created the Board of Registration for Civil Engineers in 1929, following the failure of the St. Francis Dam in northern Los Angeles

County. On March 12, 1928, the dam, which was located northeast of Castaic, suddenly gave way. A huge wall of water cascaded down the narrow valley of the Santa Clara River and when the water hit the town of Santa Paula, almost 50 miles downstream, the crest was still 25 feet high. The dam failure unleashed 12 billion gallons of water through the towns of Piru, Fillmore, Santa Paula, and Ventura before it reached the ocean. Lives lost numbered approximately 450; property damage was in the millions of dollars; 1,200 houses were demolished; and 10 bridges washed out. After the flood, inspection revealed that the dam was built on, and anchored to, a weak and faulted rock formation. The Legislature determined that the unregulated design of construction projects constituted a hazard to the public and passed laws to regulate civil engineering and to create the Board.

Although Civil Engineers first became licensed in 1929, Land Surveyors have been licensed in California since 1891. That was the year the Legislature established the State Surveyor General. However, in 1933, the Legislature abolished that office and enacted the Professional Land Surveyors' Act. The Act expanded the Board's authority to include jurisdiction over licensing of land surveyors and regulation of surveying practices. ...Regulation of land surveyors brought about uniform enforcement of survey law and is in the best interests of the state and California consumers. (from [http://www.pels.ca.gov/about\\_us/history.shtml](http://www.pels.ca.gov/about_us/history.shtml))

The history of BPELS highlights the need for society to regulate professional practice and to maintain a minimum set of standards in order to protect the

## From background noise' to one of 'raised consciousness



**Gary R Kent**  
PLS, Integrated  
Services  
Director, The  
Schneider  
Corporation

Jack's comments are interesting, although I would tend to disagree with his assessment on the current nature of the 'tension'. Perhaps it's just semantics, but I personally believe that the 'tension' is not so much growing as it is 'maturing.' For example, the MAPPS lawsuit has ostensibly raised the tension level, but I wonder if it just moved the issue from being one of 'background noise' to one of 'raised consciousness'. As I speak around the country, which I do on a regular basis, I think I detect more interest and more collaboration between the Surveying and GIS communities than in the past. ▴

health and welfare of the public. Such boards, and the licenses they oversee, are not put in place to guarantee full employment of professionals they regulate. Their sole role is to protect the public, which is also reinforced by having a majority of members being public members not directly involved with the professions under their regulation.

Apart from the regulation imposed by professional boards, the Professional Land Surveyors must practice their chosen profession under the legal precedence set down by the courts of law. For example, in Texas, one of the major texts describing the practice of professional surveying is *Decisions* by author Kenneth Gold, RPLS. In this text Mr. Gold describes how Texas surveyors conduct research and weigh both

information from recorded documents, statutes, case law, and measured evidence found in the field to arrive at the true location of legal title boundaries to real estate. In this text Mr. Gold cites approximately 550 precedent setting court cases specific to Texas that have added to the body of knowledge of how professional land surveyors should treat conflicting evidence describing the location of boundaries to real estate. A similar body of court cases is slowly mounting covering mapping and GIS products.

### Location on or near the Surface of the Earth

Of course, the surveyor is also adept and skilled in the science of measurements to determine relative location (say property corners within a subdivision) and absolute location (say relative to the national mapping grid). Throughout the history of land surveying, the science of locating position on the surface of the Earth and the measurement of the size and shape of the Earth (Geodesy) is well documented and resides within the domain of the Surveyor and a specialist surveyor, known as the Geodesist. One of the first texts on surveying in English, *Geodaesia* by John Love, was published in 1688 in London. The text describes the reduction of field measurements of angles and distances by compass and chain, then using logarithmic and trigonometric tables to compute boundary locations.

The ancient analogue measuring instruments used in 1688 have been replaced by digital measuring systems, including GPS, digital theodolites (total stations) with built-in electronic distance measurement, and digital levels using bar code reading systems. All these measurements are data logged and imported into surveying software and digital drafting software. The end products of these digital surveys are easily imported into GIS software. Much of the surveyor's time in both the field and in front of the computer is spent on making redundant checks. These built in checks are essential for the computation of accuracy and precision using statistical evaluation software. When results lie outside given

## Accuracy and consistency of GIS database is very important



**Matthew Smith**  
*Leica Geosystems*

The differences among the Surveying and GIS community largely stem from alternative academic approaches to the subject. It is well understood that it is the quality of information that matters most in a GIS database. Top level decisions are being made based upon GIS databases. Any inaccuracy or inconsistency in those databases may result in serious repercussions.

Hence, the accuracy and consistency of GIS databases are of vital importance. In such a scenario, certification of the GIS database may become an issue. Professionals who are trained in database generation definitely have a significant role to play. Surveyors are the most competent professionals to provide and analyze the quality of spatial information. But if it is insisted that only surveyors have the rights to do so, then I think the argument is taken too far. If professionals from the GIS community are capable of providing spatial information and analyzing it to the required quality, then why not? The differences between the Surveying and GIS community also reflect the conflicts of professional interests. However, there is a definite need to reduce these differences. ▴

tolerances, field measurements are repeated until the required standards are met.

Most surveyors have exposure to GIS with some actively using GIS to manage their own geospatial data. GIS software vendors are also making life easier for surveyors to use GIS by incorporating surveying functionality within GIS (a good example is ESRI's ArcSurvey). Recent surveying graduates are well versed in GIS with many university programs incorporating courses in GIS as part of the surveying degree curriculum (for example see <http://csci.tamucc.edu/gisc/>). Why is it then that most GIS enterprises do not involve surveyors?

### The Shrinking Surveying Profession

Throughout the developed world there is evidence that the total population of qualified and licensed surveyors is diminishing. A similar trend is also happening in the Engineering professions. There has been an explosion of career opportunities brought about by the rapid advance of computing power, which has widened the career horizons of potential young professionals who have a liking for mathematics, physics, and computer science. Surveying also has the handicap of having a very low public profile. The general public very rarely needs the services of a land surveyor. Surveyors provide their products and services to other professionals (engineers, architects, lawyers, government administrators, and land developers).

As a consequence of the few people

## An opportunity for convergence



**Bruce Carlson,**  
President and Founder of Carlson Software

There is an opportunity for convergence of the survey market and GIS. Surveyors create maps for record plats and for as-builts used by civil engineers, and surveyors stake out projects for construction purposes using maps provided by engineers and architects.

These maps have typically been prepared in either MicroStation or AutoCAD format. The GIS world has been dominated by the ESRI platform, which also can present maps accurately. The capabilities of these platforms in presenting 2D and 3D data have largely converged, but no single survey application solution has linked the user interface across all 3 platforms (ESRI, MicroStation and AutoCAD). Once this occurs, surveyors can choose to work in the platform of their choice and specifically can take advantage of the data links offered by the ESRI platform. Given the prevalence of ESRI in the government sector, and the fact that both survey platting and utility and infrastructure mapping is a data-rich environment, it is inevitable that surveyors will begin to consider ESRI as a mapping platform once familiar survey solutions are provided on the ESRI product base. ▴

choosing to seek careers in surveying, the profession is generally growing older. The following graph and tables show the age profile of Registered Professional Land Surveyors in Texas. Some interesting trends can be seen from these numbers:

- The number of surveyors in Texas over the past five years has remained flat while the state has one of the fastest growing populations in the U.S. and demand for surveying services continues to grow.
- There are more active licensed surveyors over the age of 70 than there are under the age of 40.

- Fully 20 percent of surveyors in Texas are of retirement age (65 years or older).

These numbers also indicate that while surveyors are declining in numbers relative to the general population, they are keeping up with overall demand for services thanks to those surveyors that choose to remain in the workforce beyond retirement age. Surveyors are also taking advantage of new digital surveying measurement equipment and software to increase productivity. It follows that the cost of surveying services are being driven higher and the demand for educated and licensed surveyors is being reflected in higher salaries being offered.

Age Group	2004 Count	2005 Count	2006 Count	2007 Count	2008 Count	2008-2007 Difference
20-29	25	20	14	26	26	0
30-39	178	180	191	211	223	12
40-49	667	646	566	540	481	-59
50-59	947	950	961	973	971	-2
60-69	516	522	541	580	617	37
70+	240	258	266	267	274	7
Total	2573	2576	2539	2597	2592	-5
< 40	203	200	205	237	249	12

Compiled by Ms. Brianne Bernsen, RPLS and Dr Gary Jeffress, RPLS

## Adding GIS to the Duties of the Surveyor

The land surveying profession has the expertise to assist the GIS industry manage the risks associated with accuracy and precision of geospatial data. Surveyors have a rich history of understanding the science behind measuring the location of objects on or near the surface of the earth and turning these measurements into legally admissible products and documents recognized by government and the courts. While many GIS products and services may not carry much risk, its value rising.

Young surveying professionals do have educated backgrounds, which include GIS, and are entering careers that see their services benefit GIS products. However, their number is very low. With the median age of surveyors being in the latter fifties, and many already being over the retirement age, we see the majority of the surveying profession in the latter stage of their careers and probably not interested in taking on the extra work associated with the growth of the GIS industry. In many areas there is more than enough traditional surveying services demand keeping surveyors gainfully employed.

While state boards, like BPELS, are concerned with protecting the public against the risk associated with geospatial data and information emanating from GIS, there seem to be few surveyors that have the desire to take on these extra duties; if mandated by board rules. There still needs to be more dialogue between the GIS industry and the surveying profession so each group better understands how cooperation can benefit all parties, including our clients. Though BPELS withdrew the proposed rules to make licensed surveyors responsible for the quality of GIS digital mapping products, the proposed rules did spark the dialogue between surveyors and the GIS industry. Ten years since BPELS proposed their controversial rules, we see the numbers of surveyors are less, while the GIS industry continues to grow. The more we learn and discuss these issues, the better we will be prepared for serving our clients in the future. ▽

## Surveyors often forget that they are also managers of spatial information



TN Wong

The Hong Kong Institute of Surveyors

Surveyors collect spatial information in the field, carry out computation so that this spatial information is geo-referenced to the local spheroid and form a local grid system.

Spatial information which is not geo-referenced can only be regarded as geographical information. We know the types of information and their uses. But, we do not know the accurate position or location of these information, such that other man-made and natural features can be related and conformed to the local grid system used by all users including GIS professional. Unfortunately surveyors very often forgot that they are also managers of spatial information. Generally the surveyors consider that GIS is not within their scope of works or responsibility. This to me is not correct.

GIS Professionals meanwhile are very keen to manage, analyze and visualize spatial information which very often were not geo-referenced. In order to tap the benefits and optimally use spatial information for national and local projects both surveyors and GIS professional must work together in the public interest. There should not

be any double efforts. This will not only save cost, time and resources but also speed up the efficiency in decision making and implementation.

Surveyors and GIS Professionals have no tension or conflict between them. Technology and internet have brought them together. The only problem is that technological development has come too fast and they find it difficult to cope with it. However the situation has now improved very much as considerable efforts are being made and there is good progress towards integrating the two professions into one. But this needs more time. The mindset of both surveyors and GIS Professionals should be to focus on this development. The future is clear and optimistic.

In my view the first thing to do is to introduce GIS syllabi in the surveying course and vice versa until such time that the two professions consider it is the right time to combine them as one course and as one profession. We may give it a name such as "Geomatics". Meanwhile both professions should sit down and work out what should be done and the ways to move forward to integrate the two professions so that Surveyors and GIS Professionals can work together to put spatial information into optimum use. But, someone has to take the lead. I am very happy to learn that our leader in GIS, Jack Dangermond is taking up the task. I have confidence that FIG, GSDI and ISPRS will fully co-operate and collaborate with Jack in this endeavour. I wish him luck and I urge all Surveyors and GIS Professionals to assist in whatever ways we can to help Jack to realize this. ▽

Send your views on Survey GIS debate to the editor at [bal@mycoordinates.org](mailto:bal@mycoordinates.org)

# “DiMAC Systems to provide a new approach to digital aerial cameras”

Mr. Julien LOSSEAU, COO of Dimac Systems s.a.r.l. in an exclusive tete a tete with Coordinates magazine during ISPRS Congress in Beijing.



**Julien LOSSEAU**  
COO, Dimac Systems

According to him, DIMAC Systems truly believes that behind its mission and desire to offer a new product lies something even more significant: the will to provide a new approach to digital aerial cameras. This concept focuses on a simple, practical and dedicated device in which functionality and flexibility prevail over rigidity and complexity, with one purpose in mind: meeting the imagery acquisition needs of aerial photography companies. It is a customer focused provider of the cost effective DiMAC<sup>ULTRALIGHT</sup> and DiMAC<sup>LIGHT</sup>, the medium format digital aerial cameras as well as the distinctive DiMAC<sup>WIDE</sup>, a large format digital aerial camera. The development of the DiMAC has been based on over 20 years of experience in aerial cartography. Following is excerpts of the interview

1 DIMAC cameras are based on 'Technology with a difference'. Please elaborate.

Compared to the other systems on the market, DiMAC SYSTEMS has developed its technology around upgradeability and modularity. It means that the same CCD sensors, set up in our camera modules can be installed in our medium size cameras (DiMAC ULTRALIGHT and DiMAC LIGHT) and in the large format camera (DiMAC WIDE). Our CCD sensors directly follow the evolution of the CCD technology also. The customer will only need to upgrade the individual camera modules as CCDs increase in size.

The TRUE COLOR and TRUE FMC technologies are very different too. We acquire the data without any need of post treatment in terms of FMC and color. Therefore, there is no loss of information. Our technology has a more straight forward architecture and thus also easy to use.



2 What edge DIMAC cameras have over other manufacturers of large format digital aerial camera?

- The modularity of the DiMAC architecture is one of the main advantages of our system. It allows different lenses and configurations for a best fit to particular project needs.
- It is also progressive: the customer can enter the digital market with one of our medium range models and upgrade it to a DiMAC WIDE whenever his needs grow
- The exceptional TRUE COLOR system allows real, sharp and well balanced radiometry. Unlike other large format cameras, no pan sharpening is involved.
- Last, but not least, our large format system is the cheapest on the market.

3 What kind of applications are DIMAC cameras best suited for?

Due to the various choice of lenses offered by the DIMAC Systems, it really fits every mapping and ortho projects and provides the most suitable configuration for any dedicated projects. From small corridor mapping to large area missions, from high altitude jobs to very precise mapping, the DiMAC range can cover every type of project by adapting its architecture and configuration.

4 What is your opinion about the growth of aerial cartography market? How do you position yourself in the same.

The aerial photography market has not even reached its maturity. There is huge demand for aerial products. The requirements are



not exclusively for industrial use anymore but also for internet geared projects (Google Earth, Yellow Pages ...). We start a new era where more applications are offered. The need of data is constantly increasing. In this scope the DiMAC, camera is well positioned. Its modularity scales for all kind of projects. Thanks to our wide portfolio of cameras (DiMAC ULTRALIGHT, DiMAC LIGHT, DiMAC WIDE), we make it easy for any company (small and large) to enter the digital market.

Furthermore, as CCD sensor technology evolves, DiMAC will easily stay on the edge of technology and provide a constant up to date product. New CCD sensors have just been announced by our manufacturers. They will directly be introduced into our camera modules to create an even larger image capture and allowing us to announce an even larger system, the DiMAC ULTRAWIDE.

# Galileo E5 signal acquisition strategies

A discussion on the complexity and problems with the Galileo E5 signal acquisition and different strategies to address these problems...



**Nagaraj C Shivaramaiah**  
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The Galileo E5 signal employs a complex sub-carrier modulation known as AltBOC(15,10) modulation. The sub-carriers are specially chosen waveforms that result in a split spectrum and a constant envelope after the modulation. Four codes are combined with these specially chosen complex sub-carriers to obtain the modulating signal which then phase modulates the E5 carrier. Alternatively, the complete modulation can be seen as an 8-PSK modulation [4, 5, 6]. The spectrum is shown in Figure 1. The transmitted signal requires a bandwidth of 51.15MHz to include the two main lobes, giving E5 the largest bandwidth of any GNSS signal.

A direct method to process the E5 signal at the receiver uses the entire 51.15MHz bandwidth and performs the correlation with the locally generated replica. This results in a correlation waveform as shown in Figure 2. The correlation waveform possesses side peaks along with a sharp main central correlation triangle. The side peaks can result in ambiguous signal acquisition.

## Acquisition complexity and the effect of code search step size

Concerns for the E5 signal acquisition include:

- The bandwidth requirement of 51.15MHz imposes a limitation on the minimum sampling frequency and is much higher than that required by other GNSS signals. Typical sampling frequencies  $\geq 122.76\text{MHz}$  have been used (see [1])
- The sharp main peak in the auto correlation function requires a code search step size reduction

which increases the number of cells to search during the acquisition as with the case of BOC signals [7].

- The side peaks of the auto correlation function pose the potential problem of false transition to the tracking process

For the AltBOC(15,10) signal, the effect of code search step size on the correlation value is shown in Figure 5. The best case and the worst case detected signal strength are chosen to obtain an insight into the sharpness of the main peak and the effect of the side peaks [10]. For BPSK the worst case correlation value follows a linear degradation with increasing step size, as expected with a symmetrical triangular correlation function. For the AltBOC(15,10) case, not only is the

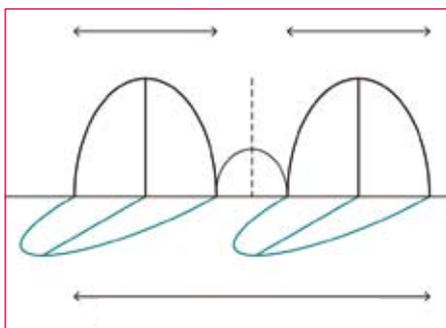


Figure 1 E5 Signal Spectrum

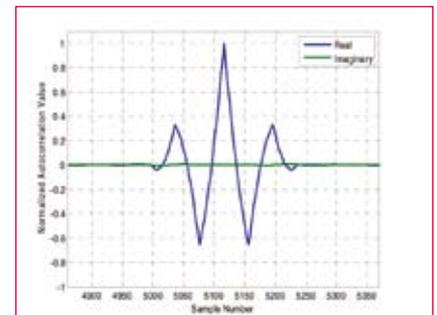


Figure 2 Normalized auto-correlation value of the unfiltered GIOVE-A PRN 51 E5 code with 120 samples per chip and arbitrary chip shift

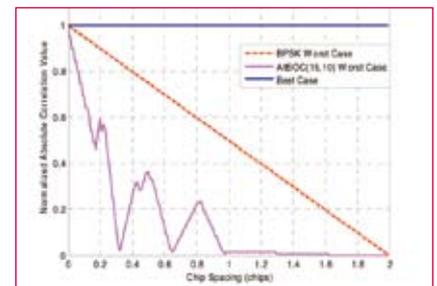


Figure 3 Effect of code search step size on the correlation value; worst case and best case for AltBOC(15,10) and BPSK Auto-correlation waveforms

degradation more steep, but there are also nulls produced by the regularly spaced autocorrelation nulls between side peaks. A typical code search step size of 0.5 experiences a loss of up to 8.8 dB relative to the best case and up to 6.3 dB loss compared to a BPSK correlation waveform with the same search step.

As an example of calculating the number of search cells, consider a one millisecond pre-detection integration period which is the length of a primary code of E5. For the same worst case correlation loss as the BPSK case of 2.5 dB (code search step size of 0.5 chips), we need to set the step size to about 0.083 chips for AltBOC(15,10). This results in  $10230 \cdot (1/0.083) \approx 122760$  search cells, the same as the number of samples in one millisecond assuming a typical sampling frequency of 122.76 MHz.

### Search strategy based techniques for acquisition

Because of the split spectrum properties of AltBOC signals, individual signals can be acquired by independently processing the main lobes. Different acquisition approaches have been studied in [1, 8].

- (1) Single Side-Band Acquisition (SSB)
  - i. E5a-Q only or E5b-Q only
  - ii. {E5a-Q, E5a-I} or {E5b-Q, E5b-I}
- (2) Double Side-Band Acquisition (DSB)

- i. E5a-Q and E5b-Q
  - ii. Non coherent combination of {E5a-Q, E5a-I} and {E5b-Q, E5b-I}
- (3) Full-band Independent Code Acquisition (FIC)
- i. Any of the E5a-Q, E5b-Q, E5a-I and E5b-I
  - ii. Coherent combination of {E5a-Q, E5b-Q} or {E5a-I, E5b-I}
  - iii. Non coherent combination of I channels and Q channels of ii)
  - iv. Non coherent combination of E5a channel and E5b channel
- (4) Direct AltBOC Acquisition
- i. 8-PSK like processing

The Direct AltBOC Acquisition method makes use of the 8-PSK principle and the local replica can be generated using a look-up table method [5, 6]. Only the direct AltBOC approach provides the complete received power. Table 1 summarizes the search strategy based acquisition approaches discussed so far.

### Correlation scheme based techniques for acquisition

Figure 4 shows the correlation waveforms for some of the approaches mentioned above.

Another class of acquisition technique proposed in the literature addresses the problem of side peak ambiguity in

BOC signals [2, 3]. These techniques concentrate on the correlation function and try to synthesize a correlation waveform without strong side peaks. Some of the related techniques are (1) ‘BPSK-like’ method proposed in [9] and modified in [3]

- (2) Sub Carrier Phase Cancellation Method (SCPC) proposed in [2]
- (3) Very Early + Prompt ((VE2+P2)) method mentioned in [2]

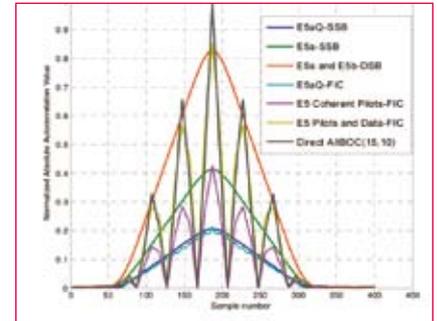


Figure 4 Normalized Absolute correlation values for different search strategies using GIOVE-A PRN 51; Side bands are filtered with a filter of bandwidth 20.46MHz

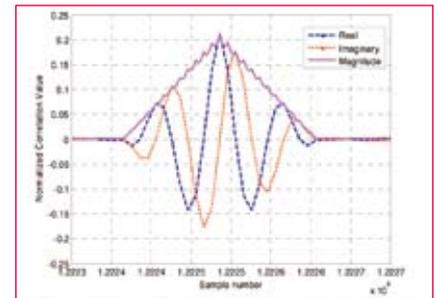


Figure 5 Normalized Correlation value for E5a-Q code of GIOVE-A PRN 51

		Extra Filter Required?	Down sampling Possible?	Code / Subcarrier Generators	Shape of the Correlation Waveform	Correlation Power(% of Direct-AltBOC)
SSB	Any One Code	Yes (one)	Yes	1 Code	BPSK(10)	21
	One Side-band	Yes (one)	Yes	2 Code	BPSK(10)	42
DSB, Both side Bands		Yes (two)	Yes	4 Code	BPSK(10)	84
FIC	Any One Code	No	No	1 Code, 1 Complex Sub-carrier	BPSK(10)	21
	Coherent Pilots	No	No	2 Code, 2 Complex Sub-carriers	AltBOC(15,10)	42
	Coherent Pilots & Data	No	No	4 Code, 2 Complex Sub-carriers	AltBOC(15,10)	84
Direct AltBOC		No	No	4 Code, one 16x8 Lookup table	AltBOC(15,10)	100

Table 1 Summary of the search strategy based schemes

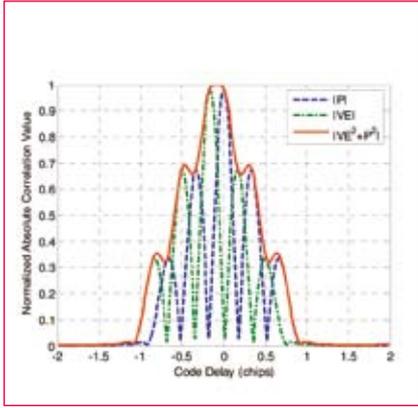


Figure 6 |VE2+P2| method for AltBOC(15,10)

The SCPC method is based on the idea of removing the sub-carrier from the received signal (after carrier removal). The correlation process FIC approach works on the basis of the SCPC method.

Figure 5 shows the E5a-Q correlation waveform. The SCPC method is not directly applicable to process the complete AltBOC signal since all the orthogonal components of the sub-carrier and the carrier have already been used to combine the four codes.

The |VE2+P2| method works on the basis that if magnitudes of two correlation values of the BOC signal separated by an appropriate delay are combined, then it results in a correlation waveform whose shape is similar to the BPSK triangle. In the |VE2+P2| method the local replica is generated as follows [2].

$$r_p(t - \hat{t}) = c(t - \hat{t}) \cdot sc(t - \hat{t}) \quad (4a)$$

$$r_{VE}(t - \hat{t}) = c\left(t - \hat{t} - \frac{T_{sc}}{4}\right) \cdot sc\left(t - \hat{t} - \frac{T_{sc}}{4}\right) \quad (4b)$$

For AltBOC(15,10) signal, the delay is 0.167 chips. The resulting correlation waveform with this method is shown in Figure 6. Observe that the shape is similar to a BPSK triangle and also the peak is flat across 0.167 chips.

We will now analyse the effect of code search step size with the |VE2+P2| method, see Figure 7. The worst case correlation values for the |VE2+P2| method are close to that of BPSK worst case values and swings around it. For 0.5 step size we incur only about 1 dB loss compared to BPSK worst case. A keen observation of the |VE2+P2| worst case loss curve shows us an interesting phenomenon. The curve shows flattened response at three places. The middle one is worth closely observing. From 0.5 to around 0.8 step size, the correlation loss remains at 0.67. This means that even at 0.8 step size we will incur only a loss of 3.5 dB and this loss is less than even the BPSK worst case at 0.8 step size.

To understand the advantage in terms of number of cell searches we again consider a one millisecond pre-detection integration period. With 0.8 step size, we need only  $10230 \cdot (1/0.8) = 12788$  cells in the first step and around 36 cells (assuming 3 chip ambiguity and 1/12 chip step) in the second step. This is a huge reduction in the number of cells to search for the acquisition (which requires 0.1 chip step for the same loss with Direct AltBOC). When compared to the 0.5 chip stepping case which requires 20460 cell searches, we obtain an improvement of about 37%.

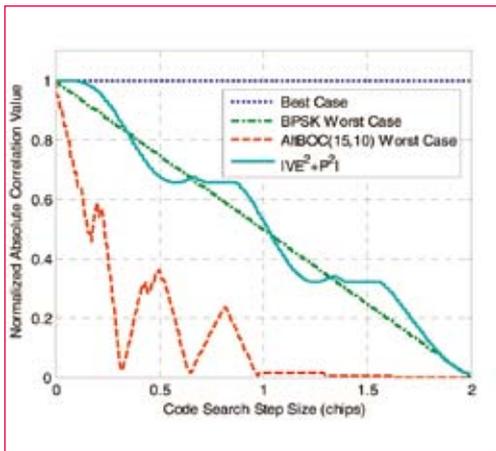


Figure 7 Effect of code search step size on the correlation values including |VE2+P2| method

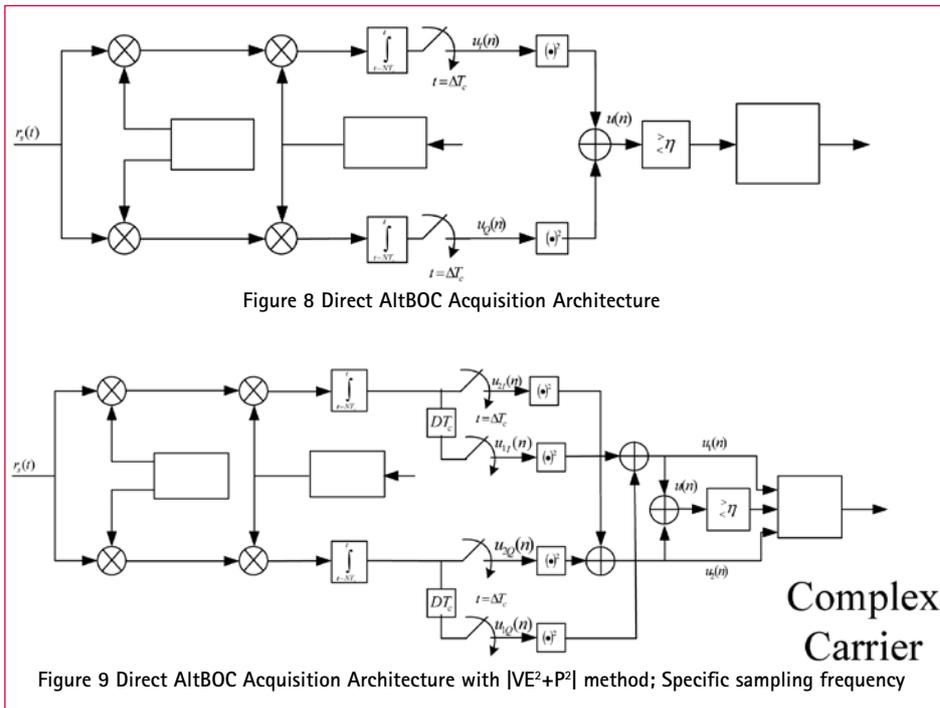


Figure 8 Direct AltBOC Acquisition Architecture

Figure 9 Direct AltBOC Acquisition Architecture with |VE2+P2| method; Specific sampling frequency

## System description

In this section we describe the acquisition engine architecture to realize the Direct AltBOC acquisition and the |VE2+P2| methods. Figure 8 shows the Direct AltBOC acquisition architecture. is the code search step size used for stepping the energy search. As discussed earlier this value is typically 0.083 chips. Once the decision is made, the control is handed over directly to the tracking process.

Figure 9 shows the architecture with addition of VE and P correlation values when the sampling frequency is such that it enables us to provide the required code delay D between the samples used for the addition. This is the case with sampling frequency of 122.76 MHz which can be used to realize the required  $D = 0.167$  chips (every alternate sample). Observe

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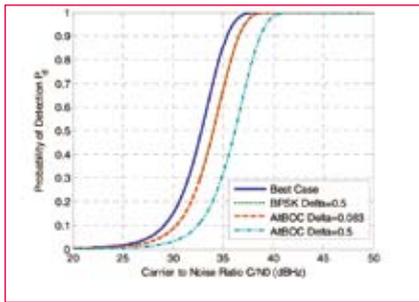


Figure 10 Average probability of detection for BPSK and AltBOC

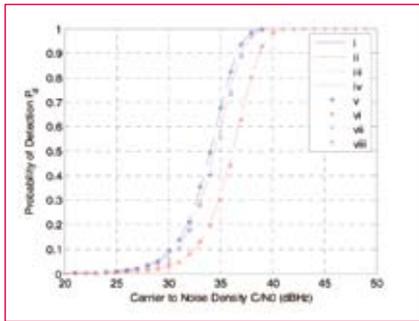


Figure 11 Average probability of detection for AltBOC and  $|VE^2+P^2|$  methods (— :Theoretical, \* : Simulation)

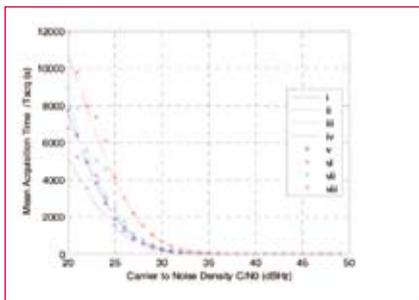


Figure 12 Mean Acquisition time for the Average probability of detection scenario (— :Theoretical, \* : Simulation)

that the architecture does not use any additional correlators compared to the previous approach. Also note that can be as large as 0.8 as discussed earlier.

### Probability of detection and mean acquisition time evaluation

Figure 10 shows the average probability of detection for BPSK and AltBOC. Note that the difference between AltBOC  $\Delta=0.5$  and the BPSK  $\Delta=0.5$  reduces to around 2.2 dB in this case.

Figures 11 and 12 provide the theoretical and simulated average probability of

detection and corresponding mean acquisition time for the  $|VE^2+P^2|$  method with both  $\Delta=0.5$  and  $0.8$  scenarios. We can see that the average probability of detection for the  $|VE^2+P^2|$  method is worse by 0.4 dB compared to the BPSK case and the  $|VE^2+P^2|$  method outperforms the Direct AltBOC approach by about 2.2 dB. Also, observe that the mean acquisition time for the  $|VE^2+P^2|$  method with  $\Delta=0.8$  chip step performs better than the BPSK case with  $\Delta=0.5$  at a given C/N0.

Legends for Figures 11 and 12: i. BPSK theoretical, ii. AltBOC  $\Delta=0.5$  theoretical, iii.  $|VE^2+P^2| \Delta=0.5$  theoretical, iv.  $|VE^2+P^2| \Delta=0.8$  theoretical, v. BPSK simulation, vi. AltBOC  $\Delta=0.5$  simulation, vii.  $|VE^2+P^2| \Delta=0.5$  simulation, viii.  $|VE^2+P^2| \Delta=0.8$  simulation.

### Conclusion

In this paper we discussed the complexity and problems with the Galileo E5 signal acquisition and revisited different strategies which address these problems. We analysed the probability of detection and the mean acquisition time for these strategies especially concentrating on the  $|VE^2+P^2|$  method along with the acquisition engine architecture.

For the same probability of detection, compared to the Direct AltBOC approach, the  $|VE^2+P^2|$  method results in an improvement in C/N0 of about 2.2 dB in the average scenario and about 5.3 dB in the worst case scenario. In addition an interesting observation shows that the correlation loss in the  $|VE^2+P^2|$  method remains constant for chip step sizes from 0.5 to 0.8 which, when exploited, reduces the mean acquisition time by 37%. We conclude that  $|VE^2+P^2|$  method is a good candidate for implementation in Galileo E5 receivers.

### Acknowledgements

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# The way we walk

Classifying pedestrian behaviour for customised mobile information services.



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**M**obile tools for wayfinding combined with Location Based Services (LBS) can provide pedestrians with practical information concerning optimal routes and useful facilities in their vicinity. However, what is considered as “optimal” and “useful” largely varies between different kinds of individuals. Inappropriate information may hinder effective information extraction for a person seeking specific navigational and environmental information; a successful mobile spatial information service should therefore be based on a profound understanding of pedestrian spatio-temporal behaviour. A current study applies an “across-method” triangulation approach for studying human spatial behaviour, combining localisation and tracking techniques as well as inquiries concerning intentions, lifestyle attributes and socio-demographic characteristics in order to define a pedestrian typology of mobility styles.

## Introduction

The rapid development in the field of mobile information and communication technologies as well as the increasing amount of ubiquitously available information offer a wide range of

possibilities to supply mobile users with location based information. In recent years, ubiquitous computing technologies have made it possible for individuals to gain ubiquitous access to information services. Facilitated access to online resources and increasing availability of location related information now give fresh impetus to the development of mobile navigation tools for pedestrians. However, the increasing availability of various kinds of information also leads to a higher risk of information overload. A successful mobile spatial information service for pedestrians must therefore be able to provide useful instructions with respect to the individual’s requirements and the specific context, and avoid redundant information.

A currently ongoing project examines the basic requirements for the development of mobile wayfinding tools based upon ubiquitous cartography. The aim is to provide pedestrians with efficient and practical information using a combination of active and passive systems in a smart environment. The wayfinding process is to be enhanced with additional, location based information and various representation forms. We aim at the description of specific types of pedestrian route choice behaviour

and interest foci, based on observed motion behaviour as well as lifestyle related attributes. Results are not only crucial for personalising navigational and environmental information, but can also be used for determining motion parameters in pedestrian simulation models. This article outlines the applied methodology for monitoring and classifying pedestrian spatio-temporal behaviour as well as initial results from the first of two consecutive empirical phases (for a more detailed description of this work see [1]).

## Investigating Pedestrian Spatio-temporal Behaviour

Several studies prove that there are differences in the way pedestrians choose a path to a particular desired destination: Pedestrians often prefer routes offering different qualities than simple shortness, e.g. the “most beautiful”, the “most convenient” or the “safest” [2-4]. Golledge [5] found that “fewest turns” (simplest path) appeared to be one of the most relevant factors influencing route planning strategies. Other factors mentioned in his results are e.g. “least time”, “most scenic/aesthetic”, or “different from previous (novelty)”. All these findings support the assumption that the choice of a specific route and the actual walking behaviour depend on a variety of influence

factors, like the task a person wants to perform, the availability of facilities in the environment, or individual preferences based on personal attitudes and lifestyles.

So far little is known about the combination of relevant factors influencing the decision to take a specific route. The complexity of pedestrian behaviour necessitates the use of various empirical methods in order to receive a comprehensive insight into route decision processes and crucial influence factors. First attempts to the acquisition and assessment of pedestrian spatio-temporal behaviour in the 1960 mainly included direct observations (also known as behavioural mapping or “tracking”) and questionnaire surveys [6]. Technological progress has led to the development of several technology-based techniques, which have been used for tracking individuals within a large environment with the help of digitally based localisation methods [7-9], or to investigate microscopic walking patterns by video analysis [10, 11]. Table 1 shows a brief summary of advantages and drawbacks of the most commonly used methods in pedestrian monitoring research.

For the current project we decided to use a combination of qualitative-interpretative and quantitative-statistical methods following the concept of

“across-method” triangulation [12] in order to minimise the specific limitations each applied method is restricted to.

## Approaching a Typology of Pedestrian Behaviour

The current approach contains of two phases of empirical data collection including observation and inquiry techniques. Figure 1 shows the design of the current study, including two phases of empirical data collection followed by hypothesis testing and the development of a model of pedestrian mobility types.

The first heuristic phase is to hypothesise and identify basic types of pedestrian route choice behaviour and movement patterns based on motion data collected by technology based tracking techniques. In the following deductive phase the initial typology is tested using a combination of localisation technologies (outdoor: GPS; indoor: Bluetooth) and detailed semi-standardised interviews. Results of both empirical phases are subsequently related to each other in order to identify specific spatial behavioural styles for the provisional categories.

### a) Heuristic Phase: Tracking

The first phase of the empirical study has been conducted in Vienna in 2007. As investigation fields a shopping centre for the indoor observations and two major shopping streets for monitoring outdoor behaviour have been chosen in order to avoid the occurrence of behavioural differences caused by different context situations. In this phase the main empirical method used for data collection consisted of unobtrusive observation (also known as “shadowing” or “tracking”).

Observation procedures started with a random selection of unaccompanied walking pedestrians and following the individual as long as possible while mapping her or his path on a digital map, recording the specific point in time and the coordinates within the map for each point of the path. After completing an observation (e.g. when the subject left the observation area or the observer lost sight

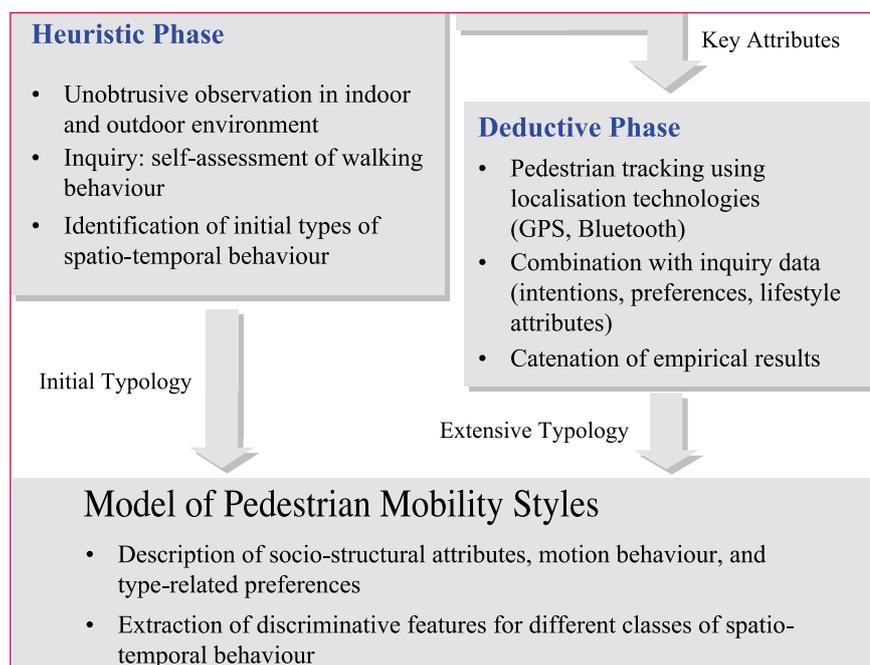


Figure 1: Study design



Figure 2: Typical trajectory including stops and velocities (colour-coded)

of the subject), additional notes concerning visible attributes of the subjects were taken (gender, age, appearance). Figure 2 shows an example of a typical trajectory including detected stops and velocities.

The analysis procedures performed on the collected data included qualitative-interpretative methods and multivariate analysis methods (factor analysis, cluster analysis). The following section describes initial results of the analysis of indoor and outdoor tracking datasets.

## b) Experimental Results

In total, 111 individuals with a balanced gender and age ratio have been observed (outdoor: 57; indoor: 54). The collected trajectories have been analysed according to the velocity computed between each marked point in the observed path; additionally locations and durations of stops within the trajectories have been

detected. Subsequently, histograms of each trajectory have been compiled, showing the proportional amount of time an individual walked at a velocity within a specific speed interval. A comparison of all histograms indicates differences in spatio-temporal behaviour in indoor and outdoor observations. Figure 3 shows that subjects observed in the indoor environment spend significantly more time standing e.g. in front or inside a shop (speed interval 1: 0-0.1 m/s) and walk in general at lower speed than subjects observed in the outdoor area.

Clustering analysis performed on both datasets form outdoor and indoor observations produced rather diverse results. While the analysis of the outdoor data showed eight discriminative clusters, the analysis of indoor observations resulted in only three homogeneous clusters of motion behaviour. This difference might be explained by the greater diversity of potential goals pedestrians might be pursuing in the outdoor environment: On a shopping street people passing by are not necessarily there for shopping (but e.g. on their way to or from work), whereas a person entering a shopping centre usually plans to buy something.

As an example the results of the indoor analysis are now explained in more detail, as the

context situation (shopping) can be assumed to be more homogeneous than outdoors. The three clusters of motion behaviour can be interpreted as “swift shoppers”, “convenient shoppers”, and “passionate shoppers”:

### Swift shoppers

This group consists of 60% male and 40% female participants who are relatively young compared to the other groups. They walk at comparably high speed (on average 1.2 m/s) and stop rarely and for a very short time (7 seconds on average, up to a maximum duration of 1 minute).

### Convenient shoppers

Almost two thirds of this group are male shoppers (64%). The average age lies between 35 and 40 years and is higher than in the comparison groups. They stop more frequently (on average 1.4 times per observation) and hence show a lower average speed (0.6 m/s). Stops last approximately 2.5 minutes (up to 8 minutes).

### Passionate shoppers

Two thirds of this group are females (67%), aged around 30 to 35 years. They stop quite frequently (about 3.6 times per observation) and for a comparatively long time (4.7 minutes on average, maximum 17 minutes). This results in a very low average speed of 0.2 m/s.

## Conclusion

Preliminary results of the first empirical

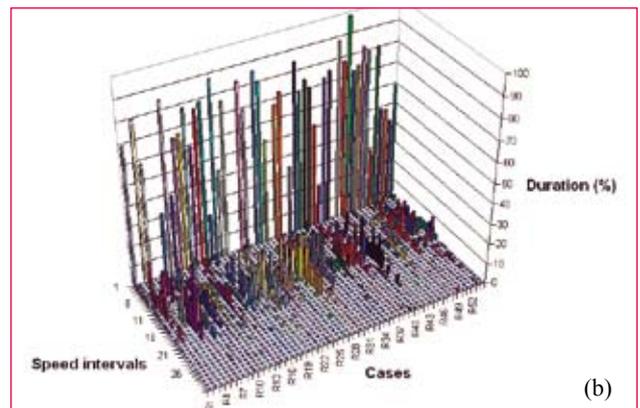
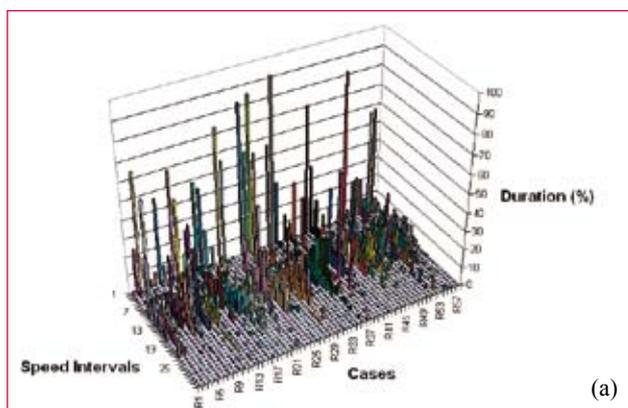


Figure 3: Histograms of all outdoor (a) and indoor (b) observations

phase indicate that a number of homogenous behaviour patterns can be observed, especially in consistent context situations. Further investigations using a non-disguised form of observation combined with detailed interviews include and currently test basic findings of the first analyses.

Further empirical analyses of more data during the currently ongoing second empirical phase as well as a careful examination of the results in different context situations during the final stage of the study are expected to lead to a comprehensive interpretation of pedestrian spatio-temporal behaviour. This can on the one hand be used in future mobile navigation services to provide customised route suggestions and location based information, and on the other hand also serve as a basis for determining parameters for pedestrian simulation models.

## Acknowledgements

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Method	Data	Pros	Cons
Questionnaire surveys	Decision processes, individual habits, motives, intentions, lifestyle attributes	<ul style="list-style-type: none"> <li>• Low costs</li> <li>• Large samples</li> </ul>	<ul style="list-style-type: none"> <li>• Inaccuracy</li> </ul>
Trip diaries	Decision processes, individual habits, motives, intentions, lifestyle attributes	<ul style="list-style-type: none"> <li>• Detailed information</li> </ul>	<ul style="list-style-type: none"> <li>• Dependant on participant’s memory</li> <li>• Varying quality</li> <li>• Small samples</li> </ul>
Direct observation	Visible activities, routes	<ul style="list-style-type: none"> <li>• Detailed information</li> <li>• “Natural behaviour”</li> </ul>	<ul style="list-style-type: none"> <li>• Time-consuming</li> <li>• Labour-intensive</li> <li>• Observer effects</li> </ul>
Video-based analysis	Visible activities, routes	<ul style="list-style-type: none"> <li>• Large samples</li> <li>• Detailed information</li> </ul>	<ul style="list-style-type: none"> <li>• Small observation field</li> <li>• Cost-intensive</li> </ul>
Localisation Technologies	Location data, routes	<ul style="list-style-type: none"> <li>• Large observation field</li> </ul>	<ul style="list-style-type: none"> <li>• Observer effects</li> <li>• Cost-intensive</li> <li>• Inaccuracy</li> </ul>

# "The success of NSDI lies in new and innovative applications"

Ir.Rudolf W.Matindas, Head of Bakosurtanal (National Coordinating Agency for Surveys and Mapping) Indonesia on various initiatives and challenges



**Ir.Rudolf W.Matindas**  
Head of Bakosurtanal (National Coordinating Agency for Surveys and Mapping) Indonesia

## What is the vision of Bakosurtanal?

Our vision is to create reliable spatial data infrastructure as a base for providing information on natural resources and environment for national development.

## The mission of Bakosurtanal is

1. To formulate macro planning and national policies in surveys and mapping , and to strengthen the coordination of national surveys and mapping activities to fulfil the need for topographic base maps up to medium scale and to fulfil the need for national thematic base maps in supporting the national development.

2. To build National Spatial Data Infrastructure (NSDI), which covers elements of institution, regulation standard, spatial fundamental data, human resources, research and technology of surveys and environment for national development.

## What are the main activities of Bakosurtanal?

BAKOSURTANAL has duty to conduct governmental duties in the field of surveys and mapping according to prevailing regulation. Our main activities include:

1. to assess and create national policies is surveys and Mapping ;
2. to develop national spatial data infrastructure (NSDI) ;
3. to coordinate functional activities in conducting Bakosurtanal task ;
4. to monitor, guide and maintain activities of government institutions in the field of national surveys and mapping ;
5. to organize, develop and serve in the field of general planning, management, organization, personnel, financial, archive, regulation, code, and internal affair.

## What is the status of NSDI?

In July 2007, establishment of NSDI was

institutionalized by a presidential decree.

The NSDI will benefit all the sectors as it would provide spatial data not only of central

Government and provincial governments but also up to local government level.

The data will be available on the net for the government and private sectors both. The time frame we see for it is ten years. Ten years is a reasonable time frame as to get information from some of the provinces will not be that easy. The NSDI initiative of Indonesia is financed by a loan from the Japan bank for International cooperation (JBIC).

We must understand that it is a beginning only, not the end. The success of NSDI lies in building new and innovative applications.

## Indonesia is often hit by various disasters. Any role Bakosurtanal?

We have Early Tsunami Warning System in place. It is supported by the German Governments as well as USA. The Bureau of Meteorology and Geophysics, Bakosurtanal and Minister of Research and Technology and other sectors are working together on the Indonesia side. We play a key role as we provide the spatial information, geodetic network and also sea level observation. Unlike the earlier days



when it was difficult to get the information of a disaster even for months, now with the help of new technologies the information move fast. Hence, our response to disaster has been more adequate. Although, we still cannot predict the disasters, but we can reduce the risks. This is carried out by giving priority to disaster prone area to be covered by adequate respective geospatial data. We can use the most current information available from satellite imageries and aerial photographs as well as database on hospital, school, infrastructure, population, etc, to help in proper assistance distribution.

The benefits of geomatics in disaster management cannot be simply quantified in economic terms as ultimately it helps to not only save human lives but also to sustain the economy as well.

### What is the status of Geomatics in Indonesia?

GIS is being used in many department of government. In private sector, the uses depend on the level awareness

and also on the affordability of the software and in turn profit possibilities on the investment made. There are vendors who are providing services.

### What are the challenges?

Knowledge. That's the only challenge. We need to make aware people about the knowledge and the potential of such technologies in various segments of development. We have centre for training for geomatics and we provide training to professionals of many government organisations. There are universities and professional associations who also provide training. I feel that GIS has progressed well in Indonesia but much more is desired. We have to move to new application areas rather focusing only on traditional applications of the technology.

### What about pricing of software?

If you buy expensive software and you sell your services at high process then

there is no problem. But if that not happens then it is a problem. I think the prices of software will remain high due to intellectual and financial investments involved. There are issues of rights and licenses also. I doubt if we can get completely free software. But in addition to the proprietary software we also join the national campaign on "Indonesia Goes Open software". We want to have dynamic software production house based on open software especially for day to day application to support the decision maker at various level of government.

### Do you think that National Mapping Agencies are getting marginalized with the advent of Google Earth?

Not at all. Such issues were raised when aerial photography arrived. It was claimed that we would be out of the business but nothing happened like that. The power of Google may be of engine for the source of finding but the majority of authorized content will be provided by the organisations like ours. ▽

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# Fuzzy logic approach for sustainable land use planning

TA Fuzzy classification approach for decision making with spatial data is proposed.



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The present study aims at developing a generic automated methodology for addressing Multi-Objective Multi-Criteria Decision-Making problems. Scientific approach which make use of analytical modeling techniques are essential to suggest suitable changes in land use and to generate action plan for an area for land and water resource development. This problem can be cast into a multi-objective multi-criteria decision-making problem.

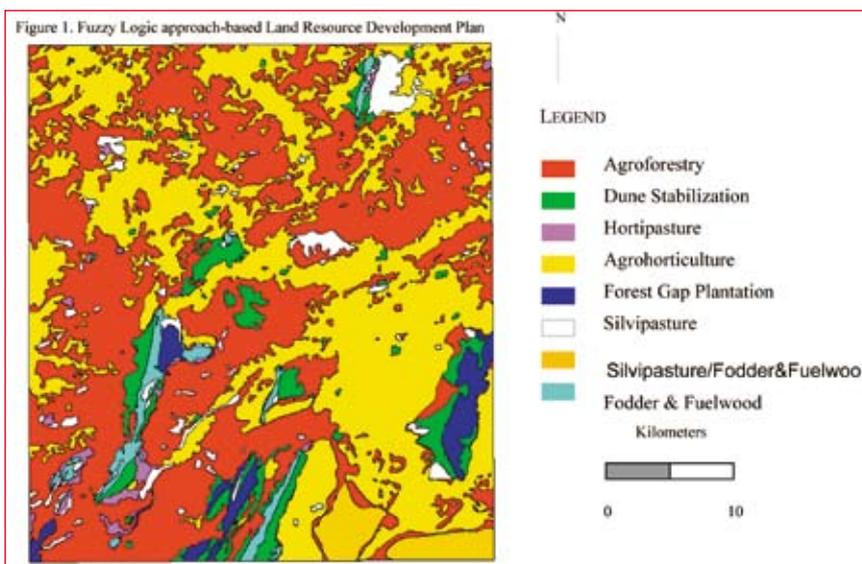
It is multi-objective in the sense one has to perform site suitability analysis for multiple objectives, which include agro-forestry, silvipasture, etc. Multiple criteria like land use, slope, soil, landform, groundwater prospects, etc, are involved in analyzing each objective. Similarly for generation of water resource action plan one has to perform site suitability analysis for check dam, percolation tank, stop dam, gully plug etc. Though the same problem can be broken into several single objective multi criteria decision-making problem, the procedure is going to be tedious.

## Multi criteria decision making (MCDM)

Multi criteria decision-making (MCDM) problems involve a set of alternatives that are evaluated on the basis of a set of evaluation criteria (Malczewski 1999). The objective of using MCDM is to help find solutions to decision problems characterized by multiple-choice alternatives, which can be evaluated by means of performance characteristics called decision criteria.

Alternate approaches to GIS-based multi criteria analysis have been suggested to overcome the problem of weighting and data integration. Combining different factors, some exclusionary and some expedient, requires a weighting factor. Analytic Hierarchy Process (AHP) is an approach that can be used to determine the relative importance of a set of activities or criteria (Saaty 1990). AHP is a technique introduced by Saaty and has been widely used in the multi-criteria decision-making process in varied fields (Saaty and Vargas, 1990). Analytic Hierarchy Process (AHP) has been identified as a weighting strategy and Compromise Programming (CP) technique has been identified for data integration (Novaline et al. 1996, Deekshatulu et al. 1999).

Multi-Objective Multi-Criteria Decision-Making method Combination of Analytical Hierarchy Process and Compromise Programming techniques worked well in solving Single Objective Multi-Criteria problems like Site Selection for Water Harvesting Structure, Landslide Hazard Zonation (Novaline et al. 2001). But such a combination cannot be effectively used for solving Multi-Objective Multi-Criteria problems. Though the Multi-



Objective Multi-Criteria Decision-Making problem can be broken into several single objective multi criteria decision making problem, solving this problem by applying combination of Analytical Hierarchy Process and Compromise Programming techniques is not going to be straight forward and effective. Moreover only absolute suitability within an objective can be addressed using MCDM techniques. In Multi-Objective Multi-Criteria Decision-Making problems, what is needed is the relative suitability for different objectives. In the present study we propose a Fuzzy classification approach in GIS for solving Multi-Objective Multi-Criteria Decision-Making problem.

## Methodology

### Fuzzy Classification in GIS

The fuzzy representation allows us to apply fuzzy techniques for geographical information processing (Burrough 1989). A fuzzy suitability rating method has been developed in this research. Compared with the conventional approaches, this method provides more information about land suitability. This approach not only solves a multi-objective multi-criteria decision-making problem, but also overcomes the information loss seen in classical set theory-based decision-making (Novaline et al., 1997).

The task of rating land suitability is to classify areas into land use classes according to their land characteristics. By

representing areas as vectors in a feature space, one can use the distance between feature vector corresponding to an area and a land use class as a measure of their similarity. The similarity indicates the extent to which the area belongs to the land use class. To measure the similarity, we define a representative vector for each land use class and view the distance between an area vector and the representative vector as the distance between the vector and the class.

If,

$C_i$  = Representative Pattern Vector of Class  $i$

$i$  = land use class

$C_i = (C_{i1}, C_{i2}, C_{i3}, \dots, C_{in})$   $n$  = No.

of physiographical characteristics / parameters

$A$  = Area Vector

A generalized family of distance metrics, dependent on the exponent  $p$ , for estimating the distance between Area Vector & Class pattern vector can be expressed as (Zeleny 1982, pp. 317) :

$$d_E(A, C_i) = \left( \sum_{j=1}^n (\beta_j p [C_{ij} - A_j]^p) \right)^{1/p} \quad (1)$$

Where  $\beta_j$  is the weight assigned to the parameter  $j$  and  $p$  ranges from 1 to  $\alpha$ .

Varying  $p$  affects the relative contribution of individual deviations from the representative pattern vector, a greater emphasis being given to larger deviations as  $p$  tends towards  $\alpha$  (Jose & Lucien,

1993). In practice, and if the natural scale scores are standardized to the range [0,1], the largest deviation ( $C_{ij} - A_j$ ) totally dominates the evaluation, when  $p$  becomes greater than a value of approximately 10. In this case, the suitability of a cell for a given purpose is only as high as its lowest score on all criteria / parameter and the evaluation relies on a min-max rule, in which the minimum of the maximum weighted deviation  $\beta_j (C_{ij} - A_j)$  is sought.

This distance metric as usually applied includes a sensitivity analysis for the three strategic values:  $p = 1, 2$  and a nominal  $\alpha$  (i.e.  $p > 10$ ). When  $p = 1$  (a 'city block' distance metric), total compensation between criteria is assumed, meaning that a decrease of one unit of one criterion can be totally compensated by an equivalent gain on any other criterion. For  $p = 2$  (a straight line, Euclidean or the shortest distance metric) there is only partial compensation and  $p = \alpha$  represents a totally non-compensatory situation (Zeleny 1982, pp.322-325). In the present implementation a value of 4 has been assigned to  $p$  after doing the sensitivity analysis for values between 1 and 10 for  $p$ . The smaller the distance, the more similar or suitable is the area to the land use class in terms of the land qualities.

In Conventional Classification,  $A \in C_i$  if  $d_E(A, C_i) < \text{distance to all other land use classes / Objectives}$ .

This decision rule defines sharp decision surfaces between classes such that a vector

**Table – 1 : A Sample Format of Decision Rules**

Agro- Horticulture	S1	S2	S3	S4	S5
Landform	Moderately weathered pediplain	Shallow weathered pediplain	Gullied Land	Pediment	Structural & Residual Hills
Slope	< 3 %	3-5 %	5-10 %	10-15%	> 15 %
Existing Landuse	Double cropped, plantations	Rabi, Kharif	Fallow	Land with scrub	Land without scrub, Barren, Forest
Soil	Fine loamy	Coarse loamy	Sandy	Loamysand, Silty clay	Sandy clay loam, Loamy skeletal
GroundWater Prospects	Good to moderate	Moderate	Moderate to Poor	Poor	Poor to Nil

Highest Suitability (S1) - Lowest Suitability (S5)

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can be classified into a single class and the classification implies a full membership in that class. Such a method is referred to as a hard partition of feature space. The method developed in this research is characterized by a fuzzy partition of feature space.

The fuzzy classification method enables one to rate an area's suitability by comprehensively taking into consideration all its characteristics and all the land cover classes. An area can be classified into the most similar land cover class. However, the classical set theory-based decision-making leads to serious information loss. This can be explained by taking two areas as examples. In determining their suitability for a given crop, the distances from the vector of the first area to the four classes are 0.50, 0.40, 0.10 and 0.00 respectively. The distances from the vector of the second area to the classes are 0.90, 0.10, 0.00 and 0.00. According to conventional classification, both areas should be classified into class 1. But, clearly the first area is much less suitable for the crop than the second area. The information contained in the distances is discarded when the area's memberships are determined. To make fuller use of the information, a fuzzy partition of feature space can be used. This method helps to suggest first best crop/land use, second best crop/land use and so on for the same area.

In a fuzzy partition, the classes are defined as fuzzy sets. An area can be associated with partial membership and belong to different classes to different extents. A fuzzy set is characterized by its membership function. We define membership function  $f_c$  for land use class  $c$  as,

In Fuzzy Classification,

$$f_{ci}(A) = \frac{d_e(A, C_i)}{\sum_{i=1}^m d_e(A, C_i)} \quad (2)$$

$f_{ci}(A)$  – Membership function  $f_c$  for land use class  $C_i$

$m$  – no. of classes

$m$

$\sum_{i=1}^m d_e(A, C_i)$  serves as a normalizing factor.

For a given area, membership functions are defined for each land use class. By calculating the functions, each area will have membership grades to all the land use classes, indicating the extent to which this area belongs to each of the land use class.

In case, the physiographical characteristics of an area are equal to those of the representative vector of suitability class  $C$ , that is

$$d_e(A, C_i) = 0,$$

the membership grade of the area in class  $C$  is defined as 1 and the grades in other classes as 0s. This implies that this area can be exactly categorized into class  $C$ .

Steps Involved:

Step 1: Normalize the Area values and Pattern Vector values for each class

Step 2: Compute the distance between Pattern Vector and Area Vector

Step 3: Convert the distances into Partial Membership functions

## Implementation

The model was implemented using ARC/INFO GIS software. Arc Macro Language was used to program.

Two problems were addressed:

1) Generation of Land Resource Action Plan

2) Generation of Water Resource Action Plan.

Land Suitability Analysis adopting fuzzy logic was done for ten land use classes, which were transformed into ten objectives. They include Silviculture, Agroforestry, Forest Gap plantation, Fuel and fodder wood species, Horticulture, Agro-horticulture, Forest enrichment, Forest protection & conservation, Horticulture and Dune Stabilization. Five terrain-related criteria namely, existing land use, soil, groundwater prospects, landform and slope were used and were analyzed within the AHP framework and were given importance in the order listed.

## Land Resource Development Plan

Land use	100
Soil	80
Ground Water Prospects	40
Landform	20
Slope	10

## Water Resource Development Plan

Lineament	100
Land use	90
Slope	70
Landform	50
Ground Water Prospects	40
Soil	20

As one has to suggest suitable sites for water harvesting structures like check dams, percolation ponds, farm ponds, gully plugs for arresting soil erosion etc, the problem tends to be multi-objective as in the case of land resource action plan. So this also can be formulated using fuzzy suitability rating method. There were four objectives i.e finding suitable sites for percolation tank, check dam, gully plug and stop dam. Six terrain-related criteria namely, presence of lineaments, existing land use, slope, landform, ground water prospects and soil were used and given importance in the order listed. For land resource development plan generation, existing land use was given higher importance, because the new land use that would be suggested, should be similar to the existing land use as people might not accept total deviation from existing land use. Soil was given next preference, as the soil conditions should support the new land use, followed by groundwater prospects, landform and slope. Whereas, for water resource development plan generation, lineaments were given higher importance, to facilitate water percolation so that groundwater is recharged. Land use was given next preference, as the developed water resource would be utilized for the land use class, which requires increased water supply. This is followed by slope and landform, which offer varying degrees of terrain restrictions for water harvesting structures. And also, water harvesting structures become essential wherever groundwater prospects are poor. Soil is being given the least preference

as its effective depth is negligible and therefore its influence on site suitability for water harvesting structures is less.

Modeling was done in raster environment. Vector data layers corresponding to various themes like land use, soil, groundwater prospects, landform, slope, lineament for a part of desert-prone district in Rajasthan were used in the model. The importance values assigned to the parameters become the  $\beta$  values in the distance equation (1). Decision Rules were framed by the resource experts for each objective (table-1). Highest suitability pattern vector (S1) represents ideal terrain conditions and always takes the highest value of 100. Terrain conditions represented by next highest suitability pattern vector S2, takes a value of 80 and so on and the Lowest suitability pattern vector S5, takes a value of 20. Terrain conditions in each cell (Area vector) were checked against the Ideal terrain conditions (Highest Suitability Pattern vector in table-1) for each objective and distance between these two vectors were found. The cell is assigned to that land use class for which the distance is closest, and therefore the membership grade is highest. Other membership grades for each cell is preserved in the database for finding the second best suitable land use or third best suitable land use. Therefore, one could get first best alternative, second best alternative etc. and there by generate different scenarios. Second best and third best alternatives become important when there is more competition for the first best alternative, which in

turn would bring down its demand.

## Conclusion

Conventional land assessment techniques are hampered by the inherent constraint of classical set theory that does not allow for partial set membership conditions and imprecise information. Consequently, one's ability to use GIS, with conventional techniques, is severely limited. In contrast, fuzzy techniques are shown to reduce information loss by obtaining membership grades for each land suitability class. Such information allows identification of the extent to which a particular area belongs to a land cover class. It is also possible to use the stored fuzzy membership grades for database queries like.

- Find the second most suitable land use/crop for a particular area

List all the areas, which are suitable for both agro-forestry and horticulture and find the suitability value

- List all the areas, which are suitable for agro-forestry or horticulture and find the suitability value. Achieving greater balance between land use and land conditions should become more feasible through implementation of the methodology described here

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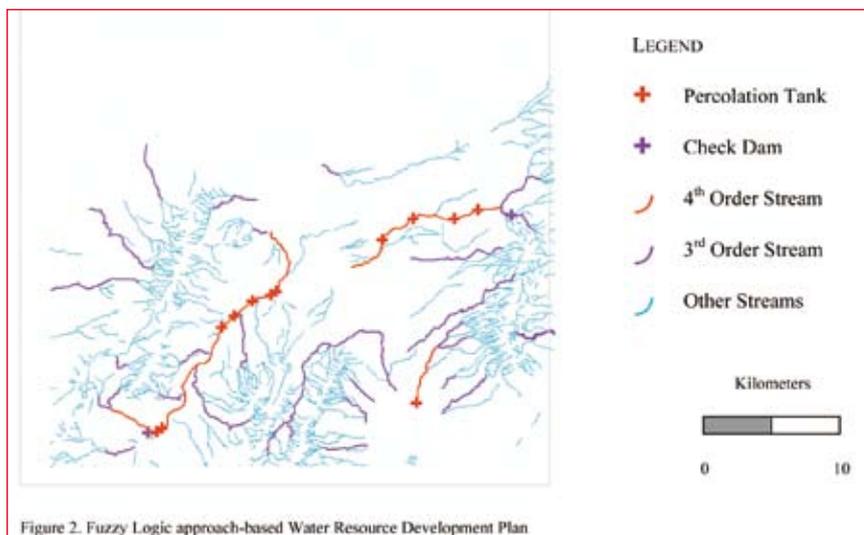


Figure 2. Fuzzy Logic approach-based Water Resource Development Plan

# Silk road for information from imagery

The XXI ISPRS Congress, 3-11 July 2008 Beijing, China

The opening ceremony of XXI ISPRS (Society for Photogrammetry and Remote Sensing) Congress was chaired by Prof Yang Kai, President of Chinese Society of Geodesy, Photogrammetry and Cartography. Mr Lu Xinse, Vice Minister of Land Resources of China, Director General of State Bureau of Surveying and Mapping of China and Chairman of National Steering Committee for XXI ISPRS Congress, and Prof Ian Dowman, President of ISPRS, delivered opening addresses. The Brock Gold Award Medal was presented to Prof Armin Gruen; the Otto von Gruber Award to Dr Matthias Butenuth; the UV Heleva Award to Martin Raubal, Stephan Winter, Sven Tessmann and Christian Gaisbauer, and the inaugural Wang Zhizhuo Award to Prof Christopher Gold.

The congress was attended by more than 2700 individuals registered with more than 1500 international registrations from 76 countries. More than 2600 technical presentations were made during the congress. During the congress, over 100 international technology providers and local mapping agencies from 25 countries have showcased their latest products, solutions and applications to geospatial community.

## Beijing Declaration (Ratified on 9 July 2008)

We, members of The International Society for Photogrammetry and Remote Sensing (ISPRS) and participants of the XXIst ISPRS Congress in Beijing, recognize the importance of imagery

to measure and monitor the natural and man-made features on planet Earth and to explore other planets of the solar system, especially after witnessing the important role of photogrammetry, remote sensing and spatial information systems in the rescue operation and damage assessment of the recent devastating natural disasters.

We note scientific developments reported during the technical sessions of the Congress and the great progress made in the use of imagery from many different platforms, with numerous sensors, for a wide variety of applications. We particularly note:

1. Wide applications of Earth observation technologies and tools to the fields of socio-economic sustainable development, natural disaster prediction, mitigation and response, maintenance of biodiversity, cultural heritage conservation, global and environmental climate change monitoring, energy exploration and management, land use and land cover inventory, food security, sustainable

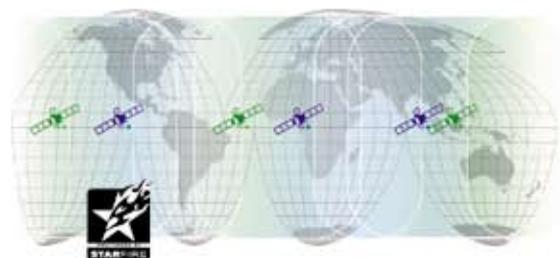
use of water resources, and human habitat, environment and health.

2. Significant technological achievement in the acquisition, processing, interpretation and analysis of aerial and satellite imagery, advances of airborne and terrestrial lidar, development of imaging radar technology, increased maturity of small satellites and of geo-sensor networks, validation, calibration and certification of digital cameras and other types of sensors, automated information extraction from all forms of imagery, distributed data processing for information services, and multidimensional data modeling.

3. Great progress in developing new forms of cooperation and knowledge sharing, including the Group on Earth Observation (GEO) and its program to establish a Global Earth Observation System of Systems (GEOSS), and the International Council for Science (ICSU) Geo-unions and its activities in Africa, and the Joint Board of Geospatial Information Societies.



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Recalling that the 2002 World Summit for Sustainable Development (WSSD) stressed the importance of Earth observation for advancing sustainable development, we strongly believe that photogrammetry, remote sensing and spatial information sciences are essential to ensure sustainable development in the 21st century.

We further recognize that non-governmental organizations, especially ISPRS, have the responsibility to promote the peaceful use of space, airborne and terrestrial technology and the realization of the full potential of imagery for the benefit of society and for the maintenance of sustainable growth in all nations.

We reaffirm our commitment to implement the vision for the 21st century of ISPRS, which aims to realize the full potential of information from imagery by encouraging and facilitating research and development, advancing knowledge by scientific networking, promoting international cooperation, pursuing interdisciplinary integration, facilitating education and training, enhancing and exploring new applications, developing public recognition of photogrammetry, remote sensing and the spatial information sciences. We therefore call on international communities to support the Cape Town declaration of GEO and:

1. to commit adequate investment and active engagement in scientific research and development, education and training, and capacity and infrastructure building;
2. to promote the sharing of imaging and ranging technology and data for scientific research and peaceful applications; and
3. to encourage constructive dialogue and close cooperation and collaboration between scientists, governments, public and private sectors, non-governmental organizations, and international organizations and institutions.

We further call for a contribution from everyone to establish and operate a new silk road for information from imagery, leading to a people-centered and sustainable development-oriented information society. ▽

# Galileo update

## Europe looks for intellectual GNSS

With a public funds set aside for Galileo and EGNOS and related projects being put out to bid, Europe is also looking for intellectual GNSS expertise to help it get Galileo in orbit.

The European Commission's director general for energy and transport is advertising for a "contractor that has extensive experience with the project management of large projects, in particular public sector procurements, and knowledgeable in a range of domains, that will assist the Commission in making strategic decisions, in taking the right programmatic approaches, in analyzing and reviewing the state of the programs at various milestones, and in putting forward recommendations. That's according to the "invitation to tender" issued by Fotis Karamitsos, head of the European Commission (EC) Directorate-General for Energy and Transport, on June 25.

This call for outside expertise arose from the moves the European Union made in late 2007 to rescue the Galileo program in the wake of the collapse of its public/private partnership funding mechanism. As part of that decision to make Galileo an entirely public project, it created the European GNSS Programmes Committee to assist the European Commission in administering the Galileo and EGNOS programs. The full invitation to tender document can be downloaded at the European Commission Directorate-General for Energy and Transport website.

## Giove-B going good

During approximately two months of in-space testing, known as the In-Orbit Test (IOT) phase, the Giove-B navigation satellite has performed excellently. Engineers from Astrium, the prime contractor for Giove-B, presented the results of the tests at the European Space Research and Technology Centre (ESTEC) in Noordwijk, Holland. The key components of the Galileo system, particularly the new signal generator and the extremely accurate Passive Hydrogen Maser atomic clock, proved to be perfectly fit for purpose, even when tested under real-time conditions. The European Space Agency (ESA), on whose behalf the mission is being conducted, confirmed the successful conclusion of the test phase during the In-Orbit Test Review (ITR) which took place on July 3rd, 2008. [www.satnews.com](http://www.satnews.com)

## European Satellite Navigation Competition with ESA special prize

For the first time ESA is offering an Innovation Prize as part of this year's European Satellite Navigation Competition. ESA has already been supporting this competition through its Technology Transfer Programme Office since the start four years ago. The aim is to find new ideas for the commercial use of global satellite navigation systems, and to kick off new businesses in this area in Europe. [www.esa.int](http://www.esa.int)



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## Leica GNSS QC and Spider V3.1

Leica Geosystems introduces GNSS QC V2.1, the latest version of the GNSS quality control and data analysis software. It includes an interface to geodetic processing packages such as Bernese by adding support for the SINEX format. It provides a convenient way of displaying and monitoring site displacements and troposphere estimates computed using high-end scientific software packages that are ideal for wide area or seismic GNSS monitoring and crustal deformation studies.

Leica has also released GNSS Spider V3.1. New are a Network based DGPS service and a unique User Location Service, providing secure external on-line access to user location information. [www.leica-geosystems.com](http://www.leica-geosystems.com)

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## Autodesk and Bentley to advance AEC Software interoperability

Autodesk and Bentley Systems agreed to expand interoperability between their portfolios of architectural, engineering, and construction software. Both will exchange software libraries, including Autodesk RealDWG, to improve the ability to read and write the companies' respective DWG and DGN formats in mixed environments with greater fidelity. The two companies will also facilitate work process interoperability between their AEC applications through supporting the reciprocal use of available Application Programming Interfaces. [www.bentley.com](http://www.bentley.com).

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## AAMHatch buy 3rd Intergraph® DMC, opens New Kuala Lumpur Office

AAMHatch has standardized on Intergraph® photogrammetry technology with the purchase of its third large format Intergraph Z/I Imaging Digital Mapping Camera (DMC®).

The company has also opened its new Kuala Lumpur office serving as south east asian regional headquarters. It continues its partnership with local Malaysian company, RS & GIS Consultancy Sdn Bhd (RESGIS) in the new offices. AAMHatch and RESGIS first worked

together on a Malaysian LiDAR project in 2003. [www.aamhatch.com.au](http://www.aamhatch.com.au)

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## Virtual Geomatics announces Sanborn as an authorized reseller for LiDAR

Virtual Geomatics has signed a reseller agreement with Sanborn to serve its customers of the VG4D Suite consisting of Production Manager, Data Manager and Viewer. The Virtual Geomatics' software solutions are deployed for production in Sanborn's Colorado Springs operations. [www.sanborn.com](http://www.sanborn.com)

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## Trimble announces the Real-Time Corrections Service

Trimble has introduced VRS Now™ H Star™ service. This service provides instant access to H-Star corrections throughout Germany, Great Britain, and the Madrid region of Spain. A subscription to the service gives users working in utilities, local government, natural resources, and land management the ability to obtain real-time, decimeter level accurate positions consistently and directly at the job site. [www.trimble.com](http://www.trimble.com)

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## Freeway 2008 Drive Time Analysis Software now available

Spatial Insights, Inc. has released Freeway 2008 and Freeway 2008 Premium, the drive time applications from Applied Spatial Technology, Inc. Freeway creates drive time polygons, as well as output tables of drive times and drive distances between multiple origins and multiple destinations. [www.spatialinsights.com](http://www.spatialinsights.com)

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## Hemisphere GPS new releases

Hemisphere GPS has introduced the LV100(TM) GPS Compass Board, the latest addition to its innovative precise heading and positioning product line. It is a complete GPS compass and positioning assembly utilizing a unique design featuring a single carrier board with integrated GPS antennas, designed for easy integration by OEM customers.

Hemisphere GPS has also released a new product for the aerial application market, the Air IntelliFlow Dual Rate

system. It is targeted at a broad range of applications, including crop spraying, pest control, forestry, and fire management.

It has also announced an expansion of its intellectual property portfolio with 4 new patents. These patents are the latest innovations in the areas of GPS positioning and automated steering. [www.hemispheregps.com](http://www.hemispheregps.com)

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## ASUS launches R2E NoteBook in India

Taiwan-based ASUS has launched its new R2E Notebook in India with GPS and multi-programme capability. It includes an 800 MHz Intel Stealy CPU, a seven inch touch panel with a SunRead glare proof panel, a 945GU Intel VGA, a 1.3 M camera, 1GB memory and Windows Vista operating system. <http://sify.com>

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## u-blox GPS chosen by Mobile Knowledge

Mobile Knowledge, a provider of commercial fleet dispatch and management solutions, has chosen a dead reckoning GPS module developed by u-blox, for a cutting edge Passenger Information Monitor & Point of Sale system being used by New York City's Yellow Taxi fleet. The NYC Taxi & Limousine Commission has approved the Mobile Knowledge and two other systems for this purpose, and has mandated that all 13,000 Yellow Cabs to be equipped by 31 August 2008. [www.u-blox.com](http://www.u-blox.com)

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## GPSi Asia signs exclusive distribution deal for China

GPS Industries, Inc. announced that its Asian distributor, GPSi Asia Pte. Ltd., has entered into an exclusive agreement for China with the Shanghai Hangying Culture Media Ltd.. The company is a GPS provider to golf courses in China with a business model that includes advertising on the GPS units. [www.tradingmarkets.com](http://www.tradingmarkets.com)

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## ERDAS adds support for WorldView-1 Satellite Data

ERDAS Inc. has announced support for WorldView-1 satellite products in ERDAS IMAGINE and LPS. It will help ERDAS

users such as GEOINT and military analysts, state and local governments, civil organizations, first responders and non-governmental organizations to transform the satellite information into timely, relevant and accurate geospatial intelligence. [www.erdas.com](http://www.erdas.com)

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### Safe Software and WeoGeo partner

Safe Software and WeoGeo have partnered to bring the powerful data transformation capabilities of FME technology to the cloud. It will make it easier than ever before for spatial data to be accessed when, where, and how it's needed. [www.safe.com/fmeserver](http://www.safe.com/fmeserver)

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### SiRF: \$332M loss, to reduce headcount by 7-9%

SiRF has announced a net loss of \$332.6 million per diluted share for its second quarter ending June 30, 2008. The revenue in the quarter was \$63.1 million, a decrease of 10.6 percent from \$70.6 million reported in the second quarter of 2007.

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### Cadcorp mSIS enhances productivity of mobile data capture users

The latest release of Cadcorp Mobile Spatial Information System enhances both mSIS Office, the desktop project management package and mSIS Mobile, the Pocket PC based data capture software for mobile mapping applications. It provides increased accuracy and flexibility in customising overlays, significantly improves the handling of attributes and supports the creation of lightweight GeoTIFF images.

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### BAE Systems to provide surveillance sensors to U.S. Army

BAE Systems has received a \$14.5 million U.S. Army contract to develop surveillance sensors. The system, to be developed under the Army's Airborne Wide Area Persistent Surveillance Sensor (AWAPSS) program, will use dual-band visible and infrared imaging technology to collect high-resolution imagery from large areas of interest. It will enable military aircraft to conduct 24-hour surveillance.

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### Intergraph® Introduces New Medium Format Digital Aerial Camera

Intergraph has introduced the RMK DT, a new medium-format digital aerial camera designed to replace film-based technology for smaller mapping and remote sensing projects and for high resolution engineering projects. The RMK D sets itself apart from other medium-format cameras by incorporating the best features available in the market into a single solution. It also features high geometric resolution, a 14 bit per pixel, high radiometric dynamic range of 70 dB, which allows users to capture quality images even in lower light conditions, and wide range digital forward motion compensation.

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### Microsoft's Vexcel Imaging Develops the UltraCamL

Vexcel Imaging has announced the UltraCamL, a smaller, lighter version of the UltraCam large format digital aerial camera system designed to better serve the needs of small mapping firms. It sets a new standard for this market segment by offering an excellent performance/price ratio and comprehensive photogrammetric capabilities, including aerotriangulation and digital surface model production. It is ideal for smaller aircraft and local projects that require a rapid response.

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### India, Canada strike S&T cooperation at \$ 17 million

A new partnership between India and Canada in researches in science and technology is in the offing. A deal to this effect was signed between the Indian science and technology minister Kapil Sibal and the Canadian minister for foreign affairs, international trade and Pacific Gateway, David Emerson in Ottawa recently, involving research initiatives also by Companies on both sides valued at more than \$ 17 million. Among the eight identified joint research projects is a next generation interoperable geo-portal solution for the emerging spatial data infrastructure market.

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### Spirent Federal GPS Simulator selected by Honeywell

Spirent Federal Systems has announced that Honeywell has selected a Spirent GPS/Inertial simulator to develop, integrate and verify the navigation system for NASA's Orion project. The Spirent simulator includes comprehensive modeling of the space environment and will provide multiple radio frequency (RF) outputs, allowing multiple antenna locations to be simulated. In addition, the system provided for the Orion project will include multiple SimINERTIAL units—Spirent Inertial interfaces that provide Honeywell engineers the capability of emulating Inertial sensor output while simultaneously simulating GPS RF signals. [www.spirent.com](http://www.spirent.com)

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### Blaupunkt enters in-car navigation devices market



Blaupunkt, a Bosch group-owned in-car entertainment products company, forayed into in-car portable navigation devices market in the country with the launch of three models under the TravelPilot series. Blaupunkt is the third organised player after SatNav and MapmyIndia in this nascent market, which is estimated at 50,000 units this year.

Announcing the launch at a press conference here, V K Viswanathan, Managing Director, Bosch Ltd, said: "We have been innovating new technologies for the mass market. Blaupunkt's latest product reflects our technological prowess and commitment towards the development of user-friendly advanced navigation systems." To begin with the company aims to sell the product through the after market. It is currently in talks with several OEMs for introducing the product as a standard fitment, he said. [www.business-standard.com](http://www.business-standard.com)

### SLA and MapKing launch free mobile StreetMap

Singapore Land Authority and MapKing (Singapore) Pte Ltd have jointly launched StreetMap@Singapore. It can be viewed on PDAs, PDA phones, and smart phones. Named as 'SLA StreetMap Mobile' it can be downloaded for free onto any mobile device running on Windows Mobile Operating System.

SLA StreetMap Mobile has similar functions with its online StreetMap@Singapore at [www.map.gov.sg](http://www.map.gov.sg). Anyone with a compatible mobile device can search for location maps using address, road name, postal code, building or development name on the move. Containing about 2,000 buildings, 4,200 named roads, and some 120,000 updated address points, it is driven by the MapKing engine. [www.sla.gov.sg](http://www.sla.gov.sg)

### Magellan to expand presence in Canada

Magellan has teamed with ReSource Group Canada, to strengthen and expand sales support to retailers and distributors across Canada. According to Canalys (June 2008 Forecast), more than 80,000 PNDs shipped last quarter in Canada, Magellan accounting for nearly 37%, about the double of its current US market share.

### MapmyIndia expands navigable map to 174 cities

MapmyIndia, has announced addition of detailed maps to its PND, MapmyIndia Navigator, now in version 2.0. Two hardware models of MapmyIndia Navigator are available: AMAX 06GP5A and Delphi NAV 200. The navigation software used has been developed by Horizon Navigation.

### Nokia finalizes NAVTEQ acquisition

Nokia has completed its acquisition of NAVTEQ for \$8.1 billion. At this stage no specific plans for future products resulting of the merger have been announced yet, however Nokia and Navteq are

working together since last summer on a solution using Nokia handsets as probe to gather traffic data. The ramping up of India's digital map is also something that has been mentioned in the first announcement of the acquisition.

### Garmin's Nuvifone to get social networking app from Gypsii

The mobile social networking provider GyPSii, signed a multi-year worldwide agreement with Garmin. It incorporates a wide range of location specific functions and mobile lifestyle services, including mobile search, user generated content-sharing and social networking. [www.gpsbusinessnews.com](http://www.gpsbusinessnews.com)

### Lenovo launches GPS-enabled laptops for SMB market

Lenovo has introduced a new range of laptops which features a GPS embedded into a broadband connectivity module from Ericsson. In the United States these notebooks are shipped with an AT&T broadband trial SIM card.

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## Vodafone UK Find & Go: web maps, local search, mobile satnav

Vodafone UK and Telmap have teamed up with Multimaps, to introduce Find & Go. This service links a web mapping portal with local search and navigation on a mobile phone. Vodafone customers can now search on their PCs on the Multimaps website and send the result to their mobile phone. Find & Go's maps, local search, and driving directions are free of charge.

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## Intrinsyc signs multi-year agreement with Navteq

Destinator navigation software Intrinsyc Software has announced a non-exclusive multi-year agreement with Navteq for the supply of map data. NAVTEQ map content will be bundled with Intrinsyc navigation software.

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## Skyhook expands to Europe, signs up LBS startups

Skyhook Wireless, provider of a Wi-Fi and hybrid positioning system, has announced its formal launch in Europe. "Skyhook has already mapped over 16 million Wi-Fi access points in Europe. Its fleet of 200 European data collection specialists has driven over 750,000 kilometers to date and continues to expand coverage every day.

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## Appello brings satnav to leading Norwegian mapping portal

Off-board navigation provider Appello Systems, and Eniro Norway have established a partnership around mobile mapping, local search and GPS navigation. Eniro is launching this week Gule Sider 1880 Navigation, a new mobile service based on Appello's GPS navigation platform Wisepilot.

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## Mexens Technology receives patent for GPS/Wireless positioning

Mexens Technology, has received a patent from the US Patent and Trademark Office for its "System and Method for Enabling Continuous Geographic Location Estimation for Wireless Computing Devices". It consists of a system combining GPS and Wireless signals

(Wi-Fi and/or cellular) to determine a position. When GPS signal is not available then the system uses Wi-Fi or cellular triangulation.

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## Verizon launched the Motorola Adventure V750

Verizon has announced the Motorola Adventure V750 smartphone. It has support for EVDO Rev. A and the Push to talk service. It offers a 2 inch QVGA internal display, GPS support with VZ Navigator, support for Field Force Manager and a 2.0 megapixels camera with video recorder. [www.mobilewhack.com](http://www.mobilewhack.com)

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## Samsung to launch its new business phone SGH-i780 in India

Samsung soon will introduce its new business phone, the Samsung SGH-i780, in the Indian market. It is a sleek Windows Mobile 6.0 device, which comes with a full touch-screen, optical mouse, stylus and full QWERTY keyboard. It also includes Integrated GPS and Google Maps. [www.topnews.in](http://www.topnews.in)

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## Caring & Sharing GPS Phone by Nokia

The Nokia 6220 classic comes with a 5 megapixel camera with autofocus and Carl Zeiss optics as well as A-GPS with geotagging. Location information can be automatically attached to photos and videos and easily uploaded to web and personal blogs, viewed on a television screen or simply shared from phone to phone. [www.smartofficeneews.com.au](http://www.smartofficeneews.com.au)

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## LBS Platforms and Infrastructure Licensing Revenues to reach \$2.2 b

Strong growth in LBS represents an important opportunity for LBS platforms and infrastructure vendors. While until recently the LBS infrastructure market was mainly driven by the E911 emergency call requirements in the US, the expected global deployment of commercial LBS applications by carriers will grow LBS infrastructure licensing revenue from \$111 million in 2008 to \$2.2 billion in 2013. The market is currently dominated by Ericsson, Telecommunications Systems and Nokia Siemens Networks with

respective market shares of 31%, 24% and 18%. Smaller independent MLC vendors such as Redknee are also making inroads into the market. Business models are reflected in a range of flexible payment options based on volume, flat fees, outright purchase, and even advertising-subsidized schemes with price levels dependent on the size of the carrier, the functionality, and the solution type. [www.abiresearch.com](http://www.abiresearch.com)

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## Mobile maps increasingly popular said comScore

Market Research firm comScore today reported that the use of mobile maps is increasingly popular in the USA and Europe, with 8 percent of American mobile subscribers and 3 percent of European subscribers accessing maps from the mobile phone in the three-month period ending May 2008. This represents a growth rate of 82 percent and 49 percent in the number of users, respectively. [www.comscore.com](http://www.comscore.com)

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## Government of Canada Funds Natural Resources Projects

The Government of Canada has announced \$674,911 in funding for a variety of projects in B.C. that rely on location-based, or geospatial, information. The nine projects, totalling \$2.1 million, are supported through GeoConnections, a national partnership program led by NRCan.

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## Location context to 3G iPhone

The iPhone App Store has just gone live and one of the apps getting early attention is Loopt, a location aware mobile social network startup. Loopt enables users to broadcast their status to a broad set of services and find interesting locations and reviews nearby. Their latest release for the iPhone integrates microblogging and reviews from Yelp into its interface. According to founder Sam Altman, Loopt is using the iPhone's rich media platform to pilot new features and services before they filter their way into other mobile phones. Loopt aggregates local content to provide a map view of great places and star ratings. <http://www.readwriteweb.com>



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## Introducing GIS for IP based network alert notification

Desktop Alert Inc. a premier provider of network centric emergency mass notification systems to the US government pronounced that it has completed its GIS for implementation with the Desktop Alert Mass Notification System being the first such implementation worldwide. It employs industry standards for GIS mapping systems. The new product has been built on using AJAX technologies along with detailed street and aerial imagery data, and an open API. It allows customization of the map output along with the ability to add situational awareness and response capabilities using application-specific data to the map. [www.desktopalert.net](http://www.desktopalert.net)

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## Geospatial technologies used for poverty alleviation in Pakistan

Government of Pakistan would replicate the Pakistan Poverty Alleviation Fund's (PPAF) Ahmedabad model of development in Hunza Valley in other parts of the country.

Located 108km off Gilgit in Ahmedabad village in Hunza Valley and supported by funding of United States Department of Agriculture, the micro hydel power project has been established by PPAF through its partner Aga Khan Rural Support Programme (AKRSP) at a cost of more than Rs. 13 million. PPAF has also established a dedicated Water Management Center with state-of-the-art GIS facilities to plan and implement projects at grassroots level. <http://thepost.com.pk/>

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## UN-HABITAT and Lebanese Army in GIS cooperation

UN-HABITAT and the Directorate of Geographic Affairs (DGA) – Lebanese Army concluded a cooperation framework to promote and further develop the nationwide GIS and mapping tools available within the DGA. It is providing the necessary support to UN-HABITAT recovery project in Southern Lebanon with the aim of establishing three Local Urban Observatories in towns of Tyre, Bint Jbeil and Jabal Amel. The agency is undertaking

a series of recovery projects in Lebanon to respond to the massive destruction caused by the July 2006 war. [www.reliefweb.int](http://www.reliefweb.int)

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## Myanmar's rice production regions monitored with GIS

Subsequent to Cyclone Nargis, a category 3 tropical storm that struck the low-lying and heavily populated coastline of Myanmar on May 2, 2008, the Foreign Agriculture Service (FAS) of the U.S. Department of Agriculture (USDA) began producing a series of GIS based maps using ESRI technology, of the damaged agricultural areas to accompany its commodity intelligence reports. FAS achieves a part of this mission by analyzing global crop production capacity with remote-sensing and GIS tools and by issuing commodity intelligence reports highlighting current international crop conditions. GIS-based maps, available in PDF format, provide a visualization of the analysis performed and often serve as each report's basis. The project included satellite imagery obtained from the National Aeronautics and Space Administration's (NASA) moderate-resolution imaging spectroradiometer (MODIS) satellite to delineate the postcyclone flooding region. [www.esri.com](http://www.esri.com)

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## Punjab may take to GIS monitoring of crops

Agricultural sustainability has gained highest priority in Indian city of Punjab, which is struggling with an abysmal agri growth rate of a little over 2 %. The Department of Science and Technology, Government of India, is mulling ways to bring science to the aid of agriculture by using GIS for crop monitoring. Andhra Pradesh has already shown how GIS can be a powerful tool for monitoring crops and natural resources, such as rivers, right up to the village level. By integrating information with remote sensing, it is gaining importance for sustaining agriculture. [www.expressindia.com](http://www.expressindia.com)

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## GIS enabled kiosks in Jaipur

This season, the tourists coming to the Jaipur, India might be saved from haggling and harassment at the hands

of four guides and escorts, thanks to various infrastructure upgradation plans. The government is planning to set up touchscreen information kiosks, among other things, to make the city tourist-friendly. The proposal is to have these kiosks furnished with comprehensive details with inbuilt GIS location maps that can also be pulled out at the touch of a button. The kiosks would provide detailed information on all the tourist destinations in the state, which include monuments, forts, palaces and museums. The kiosks would also provide online information on hotels, important routes in the cities and about tourist vehicles along with their normal tariffs. Details of road, railway and air services would also be made available on the kiosks <http://timesofindia.indiatimes.com/>

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## Mapping out new deal for Shanghai street traders

The Shanghai Public Sanitation Bureau is going to make a clean sweep of illegal street vendors with a new digital map service. The map, which will be published on the Internet, will name the streets where road-side vendors are allowed and show the indoor sites where they can set up their businesses. Trading hours will also be shown.



“It’s a reasonable solution to meet the demands for road-side vendors without upsetting normal urban management,” the bureau said. For years road-side stalls have been illegal and a concern as unsupervised street traders sometimes disturb the populace and can involve criminal activities. <http://www.shanghaidaily.com/>

## In-Stat expects Chinese GPS handset market to grow rapidly

According to In-Stat, “the Chinese GPS phone market is still small and has low penetration, but its high growth rate is a clear signal of its development, as is the fact that it is starting to have an impact on the growth of the PND market”. The findings of this report shows shipments of GPS phones will exceed 5 million in 2009 and will account for about 10% of total mobile phone shipments in 2012, compared to 0.6% in 2007. In 2008, more mainstream handset manufacturers have begun GPS phone production, and the number of models available will be at least three times that of those in 2007.

## Industrial Precision GPS Solutions Market to Continue Growing 25%

While much of the current attention surrounding GPS technology is focused on consumer navigation and LBS devices and services, the less well known industrial GPS applications such as precision agriculture, surveying, GIS, construction machine control, network timing, marine and avionics are increasingly being adopted

by companies to increase quality, security and efficiency, as well as reduce costs. In order to reach centimeter and even millimeter accuracy, GPS technology is stretched to its limits by using dual frequency, DGPS and RTK-based receivers combined with correction signals to compensate for atmospheric and timing errors. GPS is often complemented by other technologies such as sonar, radar, radio, laser, or optical systems. Precision GPS technology will benefit from the upgrade of the existing GPS satellite system. New civilian frequencies and signals, as well as the increased transmission power provided by next-generation GPS III satellites will increase both accuracy and coverage. It will be further enhanced by the rollout of Galileo in future. [www.abiresearch.com](http://www.abiresearch.com)

## Raytheon leads team bidding on Indian satellite navigation system

Raytheon Company is leading a team to deliver a comprehensive solution for the Indian Space Research Organization and Airports Authority of India GNSS. This will complete the final phase of the GPS-Aided Geosynchronous Augmented Navigation System, or GAGAN. GAGAN

will provide satellite-based navigation for civil aviation across South and East Asia. The Raytheon team will leverage the experience it gained during the past several years in deploying the technology demonstration system phase of GAGAN. For instance, the Wide Area Augmentation System was certified by the Federal Aviation Administration in July 2003, and the MTSAT Satellite Augmentation System was certified by the Japanese Civil Aviation Bureau in September 2007. Team members from India are Accord Software and Systems, Pvt. Ltd. Elcome Technologies, Pvt. Ltd.; and Naverus, Inc., of Kent, Washington, USA. [www.prnewswire.com](http://www.prnewswire.com)

## Tamil Nadu's fishing boats to get GPS for protection

In a bid to protect Indian fishermen from attacks by the Sri Lankan navy, Tamil Nadu has decided to equip boats plying between the two countries with GPS to keep track of them. GPS system will be installed in 1,697 mechanised boats and 4,620 non-mechanised ones to be implemented by the Electronic Corporation of Tamil Nadu. It is estimated to cost Rs.77 million. [www.thaindian.com](http://www.thaindian.com)

## IIT Kanpur proposes micro satellite to ISRO

IIT Kanpur has submitted a proposal to the Indian Space Research Organisation, relating to design and development of a micro satellite. It shall weigh around 7 kgs, can be used as part of disaster management and in cartography. The project was expected to require a funding of around Rs 5-7 crore. [www.business-standard.com](http://www.business-standard.com)

## Brazil harnesses space tech to monitor deforestation

Brazil will launch a satellite in 2011 to monitor deforestation and urban expansion around the world, it has been announced. Amazônia-1 will carry a UK-made high resolution camera. It is part of the continuing UK—Brazil Partnership in Science and Innovation,

and stems from discussions between governments and research partners that began in 2007. Amazônia-1 will orbit the Earth 14 times a day from 400 miles. It will have 3 cameras in total, 2 of them made in Brazil and one made in the UK. [www.environmental-expert.com](http://www.environmental-expert.com)

## Satellite maps used to reveal ideal locations for wind farms

Efforts to harness the energy potential of Earth's ocean winds could soon gain an important new tool. Global satellite maps from NASA. Scientists have been creating maps using nearly a decade of data from NASA's QuikSCAT satellite that reveal ocean areas where winds could produce wind energy.

The new maps have many potential uses including planning the location of offshore wind farms to convert wind

energy into electric energy. QuikSCAT tracks the speed, direction and power of winds near the ocean surface. Data collected continuously by a specialized microwave radar instrument named SeaWinds, also are used to predict storms and enhance the accuracy of weather forecasts. [www.azobuild.com/](http://www.azobuild.com/)

## ESA satellite assesses damage of Norway's largest fire

Norway experienced its biggest forest fire in the last half century recently. Envisat satellite images were used in the fire's aftermath to get an overview of the damaged area for authorities and insurance companies. To assess the full extent of the damage, Norway's the Kongsberg Satellite Services compared Envisat acquisitions taken before and after the event. [www.sciencedaily.com](http://www.sciencedaily.com)

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#### 14th PCGIAP Meeting

August 19-22, 2008 in Kuala Lumpur, Malaysia  
[www.pcgiaip.org](http://www.pcgiaip.org)

#### GITA 2008

25-27 August Sydney, Australia  
<http://gita.org.au/08sydney.php>

### September 2008

#### Symposium on High Mountain Remote Sensing Cartography

8-11 September Kathmandu, Nepal  
[pmool@icimod.org](mailto:pmool@icimod.org)

#### VIIIth International Scientific and Technical Conference "From imagery to map: digital photogrammetric technologies"

15-18 September 2008, Porec, Croatia  
[www.racurs.ru/Croatia2008/?lng=en](http://www.racurs.ru/Croatia2008/?lng=en)

#### Institute of Navigation's Satellite Division ION GNSS 2008

September 16-19, 2008  
Savannah, Georgia, USA  
[www.ion.org](http://www.ion.org)

#### European Surveyors Congress Strasbourg 2008

17-19 September, Strasbourg, France  
[a.grandperrin@publi-topex.com](mailto:a.grandperrin@publi-topex.com)  
[www.geometre-strasbourg2008.eu/?lang=en](http://www.geometre-strasbourg2008.eu/?lang=en)

#### CARIS 2008

September 22 - 26, Bath, United Kingdom  
[www.caris.com/caris2008](http://www.caris.com/caris2008)

#### GIS in Mining & Exploration

September 22 - 25, Brisbane, Australia  
[www.iqpc.com/showevent.aspx?id=101084](http://www.iqpc.com/showevent.aspx?id=101084)

#### Asia GIS conference 2008

26 - 27 September, Busan, Korea  
[suh@pknu.ac.kr](mailto:suh@pknu.ac.kr)  
<http://www.asiagis2008.com>

#### INTERGEO

30 Sept- 2 October  
Bremen, Germany  
[www.intergeo.de](http://www.intergeo.de)

### October 2008

#### GIS'14 Conference

October 21-23, 2008  
Hochiminh City  
[Phuoc.gis@uit.edu.vn](mailto:Phuoc.gis@uit.edu.vn)

#### The European Navigation event,

October 7-8 2008,  
High Tech Campus, Eindhoven,  
The Netherlands  
[e.wendrich@jakajima.eu](mailto:e.wendrich@jakajima.eu)  
[www.jakajima.eu](http://www.jakajima.eu)

### November 2008

#### XXVIII INCA International Congress on Collaborative Mapping and Space Technology

Nov. 4-6, 2008  
Gandhinagar, Gujarat, India  
[inca2008@sac.isro.gov](mailto:inca2008@sac.isro.gov)  
[www.cmap.org.in](http://www.cmap.org.in)

#### ACRS 2008

10 - 14 November  
Galadari Hotel, Colombo, Sri Lanka  
[acrs2008@slt.net.lk](mailto:acrs2008@slt.net.lk)

#### International Symposium on GPS/GNSS 2008

11 - 14 November, Tokyo, Japan  
[gns@gns2008.jp](mailto:gns@gns2008.jp)  
<http://www.gns2008.jp>

#### International Symposium on Global Navigation Satellite Systems

Berlin, Germany, 11 - 14 November 2008  
[anette.blaser@senstadt.berlin.de](mailto:anette.blaser@senstadt.berlin.de)  
[www.eupos.org](http://www.eupos.org)

#### 3D Geo-Information Workshop

13-14 November  
Seoul, South Korea  
[3DGeoinfo@uos.ac.kr](mailto:3DGeoinfo@uos.ac.kr)  
<http://3dgeoinfo.uos.ac.kr>

### December 2008

#### GEOExpo 2008 China

2 - 4 December 2008,  
Shanghai, China  
[sales@chinageo-expo.com](mailto:sales@chinageo-expo.com)  
<http://www.ChinaGeo-Expo.com>

## CANALYS Navigation Forum 2008

8-10, Sep, Budapest, Hungary  
14-15 Oct, San Fransico, USA

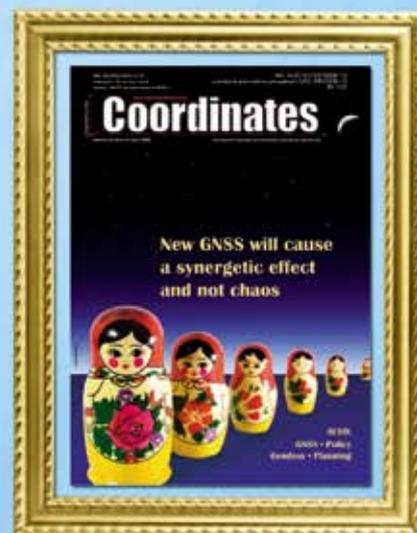
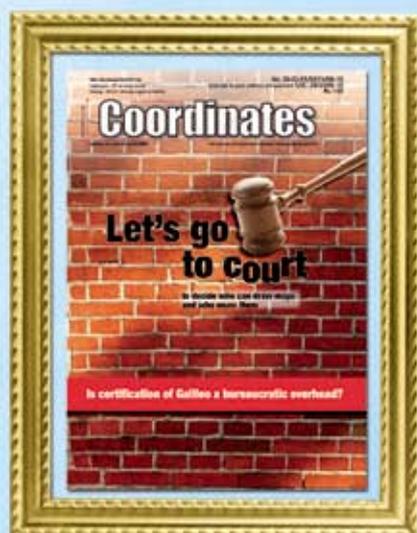
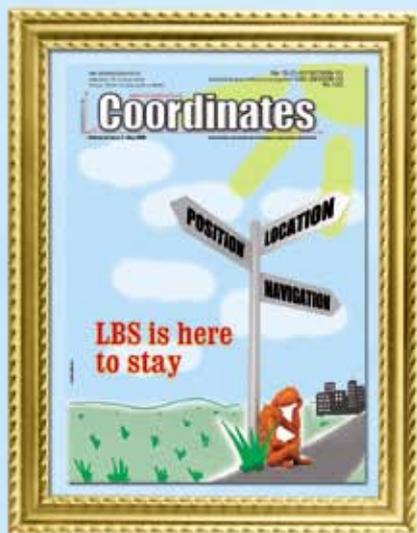
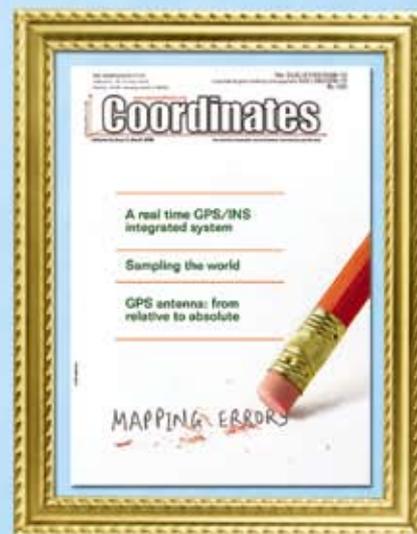
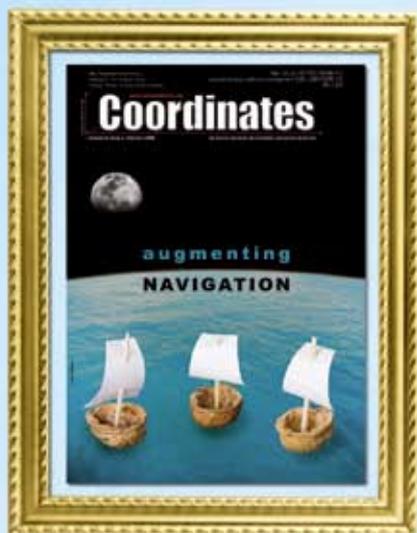
[Gemma\\_whittaker@canalys.com](mailto:Gemma_whittaker@canalys.com)  
[www.canalysnavigationforum.com](http://www.canalysnavigationforum.com)

## GIS'14 Conference

October 21-23, 2008  
Hochiminh City  
[Phuoc.gis@uit.edu.vn](mailto:Phuoc.gis@uit.edu.vn)



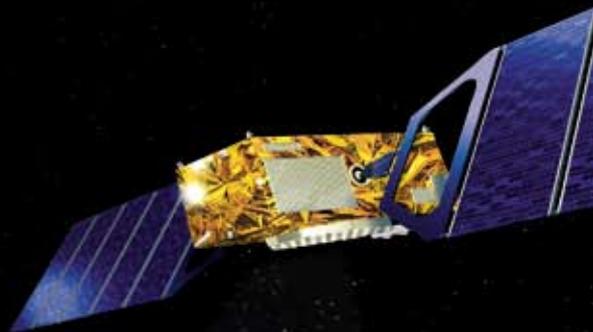
# Hall of Fame



# GRANADA

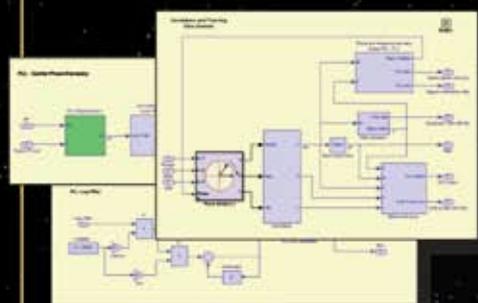
Galileo Receiver Analysis And Design Application

The Reference Galileo Simulation Toolkit  
for GNSS Receiver Research and Development



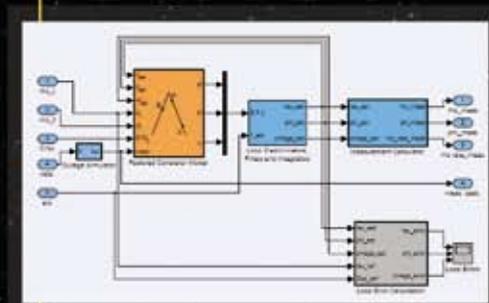
## ENVIRONMENT AND NAVIGATION SIMULATOR

- Multisystem navigation analysis (Galileo/GPS)
- Graphical user interface for constellation, environment and receiver configuration
- Raw data and range errors generation



## BIT-TRUE GNSS RECEIVER SIMULATOR

- Open MATLAB/Simulink environment for educational, R&D, and testing
- IF sample based signal generation and processing
- Fully configurable receiver architecture
- Up-to-date GPS/Galileo signals including MBOC



## FACTORED CORRELATOR MODEL

- MATLAB / Simulink blockset for multichannel receiver simulation
- Intermediate tool for acquisition, tracking and raw data generation
- Swift, flexible and realistic solution based on analytical model of correlators