Imaging NOTES

EARTH REMOTE SENSING FOR SECURITY ENERGY AND THE ENVIRONMENT

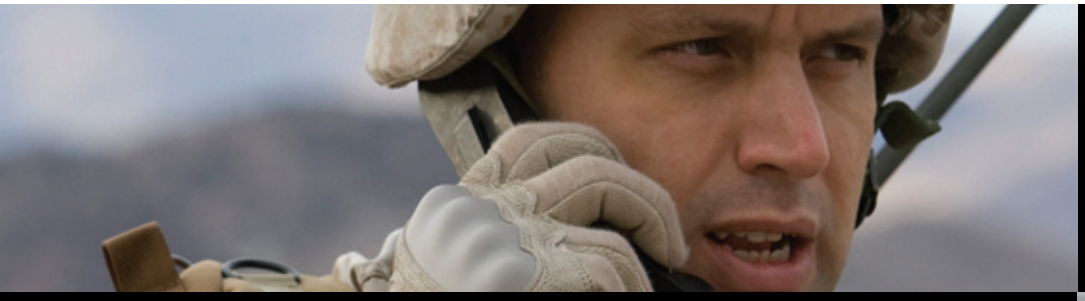
Fall 2009
Vol. 24 » No. 4

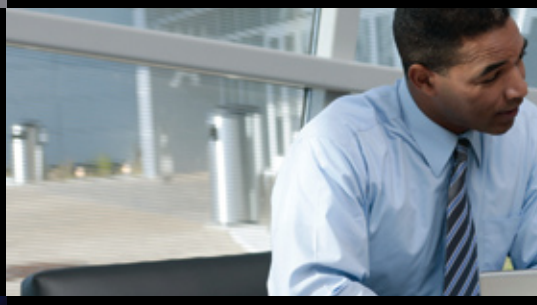
Building Iraqi GEOINT

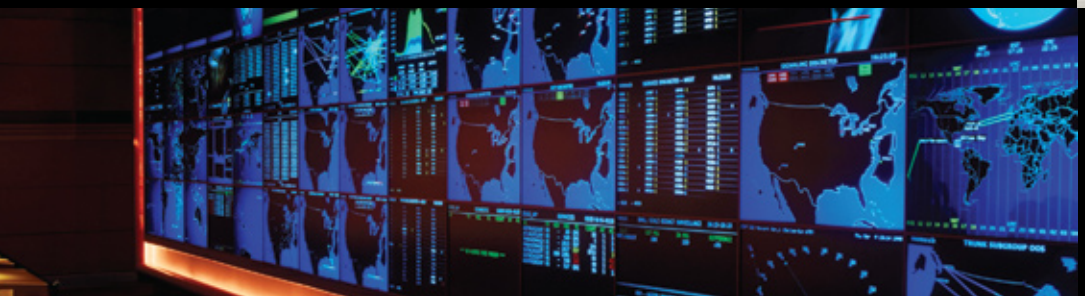
UAVs

COMMUNITY REMOTE SENSING

4D: TIME







Driven

by the Power of Partnership

NJVC's commitment to the Intelligence Community, Department of Defense, and the geospatial intelligence community at-large is unwavering. As one of the top 20 IT contractors in DoD and the largest information technology provider to the NSG community, NJVC is deeply engaged with the global GEOINT mission. Our service solutions are optimized to advance the GEOINT tradecraft. We are proud of our history of leadership to this community and the critical mission that we support.

NJVC
Driven by Your Mission™

www.njvc.com

Global Geospatial Services

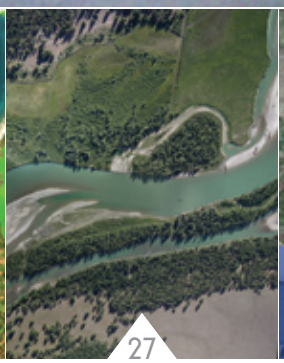
No other company in the world can offer the same comprehensive range of geospatial solutions.

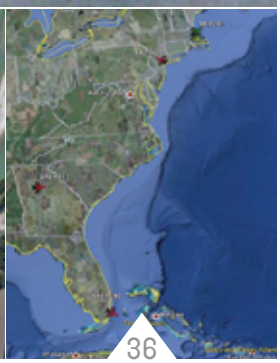
Fugro EarthData is uniquely qualified to deliver a full range of geointelligence solutions, anywhere in the world:

- Military mapping
- Terrain analysis & characterization
- Geodetic surveying
- Urban visualization
- Littoral mapping
- Disaster response & recovery
- Change detection

Technology. Experience. Global Reach.

www.fugroearthdata.com





Fall 2009

CONTENTS

>COLUMNS

>FEATURES

Baghdad, Iraq

COVER IMAGE

This satellite image of Baghdad, Iraq, shows The International Zone (commonly called The Green Zone) and the Tigris River. A newer image of Baghdad from a few months ago from GeoEye-1 appears on page 20.

The circle in the center left is the Tomb of the Unknown Soldier. (Another photo of this monument appears on page 24.) Immediately to the east (right) is the expressway. Following the expressway south to the Tigris River is the July 14th Bridge, which was named in honor of the July 14, 1958 military coup that overthrew the Iraqi Hashemite monarchy, creating the Republic of Iraq. This bridge through The International Zone is closed, and is scheduled to re-open soon.

From the July 14th Bridge, following the Tigris River going west is a lake on the north side. Along the north shore of this lake is the location of the palace pictured on page 23, said to be built for Saddam Hussein's daughter. It appears at the very left edge of the cover image.

Building the Iraqi Imagery and Mapping Directorate is the subject of the article that begins on page 20. It is written from the perspective of an NGA Staff Officer and Canadian Army Lt. who voluntarily deployed to support the Multi-National Security Transition Command-Iraq, and the Iraq Ministry of Defense. More information about the monuments and photos is included in the article.

This image of the Baghdad Green Zone was taken Feb. 16, 2004, by the IKONOS satellite. It is shown courtesy of Space Imaging Middle East.

Imaging NOTES

Fall 2009 / Vol. 24 / No. 4

OUR MISSION

Imaging Notes is the premier publication for commercial, government and academic remote sensing professionals around the world. It provides objective exclusive in-depth reporting that demonstrates how remote sensing technologies and spatial information illuminate the urgent interrelated issues of the environment, energy and security.

Imaging Notes has a partnership with Secure World Foundation (www.secureworldfoundation.org).

Imaging Notes is affiliated with the Alliance for Earth Observations, a program of The Institute for Global Environmental Strategies (www.strategies.org).

PUBLISHER/MANAGING EDITOR
Myrna James Yoo
myrna@imagingnotes.com

EDITOR
Ray A. Williamson, PhD
ray@imagingnotes.com

COPY EDITOR
Bette Milleson

ADVERTISING DIRECTOR
Colleen Gormley

CREATIVE DIRECTOR
Jürgen Mantzke
Enfineitz LLC
jurgen@enfineitz.com
www.enfineitz.com

DEPUTY ART DIRECTOR
Andrew Sternard

EDITORIAL ADVISORY BOARD

Mark E. Brender, GeoEye

Nancy Colleton
Institute for Global Environmental Strategies

Timothy W. Foresman, PhD
International Centre for Remote Sensing Education

William B. Gail, PhD
Microsoft Virtual Earth

Anne Hale Miglarese
Booz Allen Hamilton

Kevin Pomfret, Esq.
Cantor Arkema, P.C.

EDITORIAL CONTRIBUTIONS

Imaging Notes welcomes contributions for feature articles. We publish articles on the remote sensing industry, including applications, technology, and business. Please see Contributor's Guidelines on www.imagingnotes.com, and email proposals to editor@imagingnotes.com.

SUBSCRIPTIONS

To subscribe or renew, please go to www.imagingnotes.com, and click on 'subscribe.' If you are a current subscriber, renew by locating your account number on your address label to enter the database and update your subscription. If you cannot go online, you may write to the address below.

Imaging Notes (ISSN 0896-7091) Copyright © 2009
Blueline Publishing LLC
P.O. Box 11569, Denver, CO 80211
303-477-5272

All rights reserved. No material may be reproduced or transmitted in any form or by any means without written permission from the publisher. While every precaution is taken to ensure accuracy, the publisher and the Alliance for Earth Observations cannot accept responsibility for the accuracy of information or for any opinions or views presented in ***Imaging Notes***.

Although trademark and copyright symbols are not used in this publication, they are honored.

Imaging Notes is printed on 20% recycled (10% post-consumer waste) paper. All inks used contain a percentage of soy base. Our printer meets or exceeds all federal Resource Conservation Recovery Act (RCRA) Standards.

Everything you need to turn vision into action. Our expert geospatial intelligence services capture the decision-critical data you need. And when it matters most, GeoEye is committed to delivering high-resolution, map-accurate data to you on time, the first time. Whether you're developing time-sensitive, special-operations or strategic plans, we help you assess the conditions on the ground for maximum insight when it really matters. Before you act.

Image intelligence. Delivered intelligently.

GeoEye®

www.geoeye.com/def

© 2009 GeoEye. All Rights Reserved.

Community Remote Sensing

IGARSS 2010 THEME

SECURE WORLD FOUNDATION FORUM

For nearly the first three decades of satellite remote sensing, the utility of the data was limited by the expert knowledge of complex software required to make full use of the data's capabilities. The software and training needed conspired to make this difficult. Even governments and well-heeled companies were slow to incorporate the benefits of this powerful space technology into their operations. However, over the past decade the proliferation of GPS applications and the development of simpler geographic information systems (GIS) tools have broadened the attractiveness of satellite data.

At the same time, in order to keep pace with the competition presented by the digital format of satellite remote sensing, aircraft sensing has evolved to use large digital cameras and radar devices for specialized high-resolution information products, adding new depth to the marketplace. Satellite and aerial remotely sensed data are now much easier to incorporate into business and government processes than ever before.

I would argue, however, that the really big breakthrough in market access to data came with the advent of Google's Google Earth Web application in 2005. Nearly instantaneously, Google Earth brought millions with access to the Internet a quick way to see what their neighborhood looked like from space, or to look back on their childhood home. It also allowed business people rapid access to information about potential future business locations. Yet its real power is in the hundreds of applications that individuals, non-governmental organizations (NGOs), and businesses have developed using the application. For example, the website, http://www.biblemap.org uses Google Earth to display the places mentioned in the Bible. Also included is extensive information about the site and its relationship to the books of the Bible.

RAY A. WILLIAMSON, PHD, is editor of *Imaging Notes* and Executive Director of the Secure World Foundation, an organization devoted to the promotion of cooperative approaches to space security (http://www.SecureWorldFoundation.org).

What excites me about the ease of use that Google Earth and Microsoft's Bing Maps platforms provide is that they supply the stage for involving ordinary citizens in taking better control over their own local environments by using remote sensing to influence policymakers. For example, Appalachian Voices, an environmental advocacy group in the Eastern United States (www.appvoices.org) has used Google Earth and a plethora of local data gathered by citizens to show the sometimes disastrous effects of mountaintop coal removal on local communities located down slope from the mining operations (Imaging Notes, June 2007).

The key here is the incorporation of local data into the overall picture that Google Earth provides. Ground level digital photographs (another form of remote sensing) and videos (yet another form of remote sensing), and audio clips can be incorporated into the mix of information to provide a compelling and detailed story that policymakers respond to.

What now makes it easy to bring local data into the picture to provide additional granularity to aircraft or satellite images are the many new digital applications, such as SmartPhones, netbooks, and other wi-fi and internet applications. Facebook, Twitter, and other citizen news feeds from the recent unrest in Iran following the disputed presidential election provide ample proof of the power of using these new tools to gather information quickly and efficiently. Need to gather photo data quickly on a given area? Twitter your colleagues to pick up their GPS-capable digital cameras, or better yet their camera cell phones and send you the pictures, with the GPS information built in.

More sophisticated uses could include temperature and pressure measurements, encoded with location and time coordinates, obtained from individual mobile phones, and sent to a central location to contribute to the creation of high-resolution weather models of an area. This would be the logical extension of applications like the well-known WeatherBug Internet that relies on weather observations at small weather stations at schools around the United States to provide local weather information.

In another application, students at the International Space University this

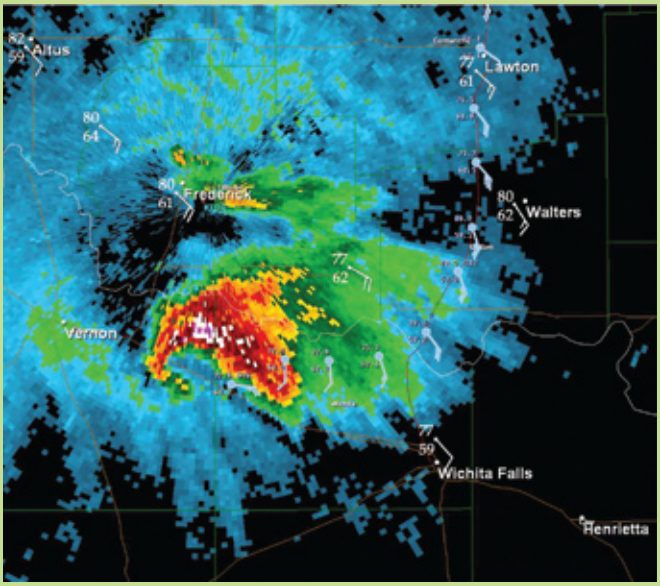
THE IMPORTANCE OF SUCH CAPABILITIES FOR ENHANCING HUMAN SECURITY CANNOT BE UNDERSTATED. THEY CONTRIBUTE IN TWO IMPORTANT WAYS: FIRST, THEY ENABLE THE RAPID COLLECTION OF LOCAL INFORMATION THAT CAN PROVIDE GREATER DEPTH TO THE INTERPRETATION AND UNDERSTANDING OF LOCAL AND REGIONAL ENVIRONMENTAL AND GEOGRAPHICAL CONDITIONS; AND SECOND, THEY ENABLE LOCAL PEOPLE TO ENGAGE DIRECTLY WITH THEIR COMMUNITIES AND THEREBY TAKE GREATER CHARGE OF THEIR OWN DESTINY

summer at the NASA Ames Research Center in California developed a SmartPhone application designed to enable the quick and efficient collection of data about urban buildings (number of floors, age, type of construction). The data, which can be collected by a few teams of university students in a relatively short time, would be added to the aerial and satellite data available for Belize. They are intended to be used to populate a World Bank-developed database designed to assist the country of Belize in reducing its risk from natural disasters.

The possible applications of such a mash-up of distributed observations and remotely sensed data from aircraft or satellites are limited only by the human imagination. The importance of such capabilities for enhancing human security cannot be understated. They contribute in two important ways: first, they enable the rapid collection of local information that can provide greater depth to the interpretation and understanding of local and regional environmental and geographical conditions; and second, they enable local people to engage directly with their communities and thereby take greater charge of their own destiny.

Sensing severe weather from automobiles

Distributed data collection uses the community to augment centralized remote sensing data sources. This figure illustrates how simple weather sensors on automobiles can greatly enhance our ability to detect severe weather events. The color scale represents the Doppler radar data in a portion of Texas and shows an area of severe weather that could be a forming tornado. The labeled items are current weather data from fixed stations, while the non-labeled items (in light blue) are weather obtained from a moving automobile. A distinct change in wind direction is observed by the automobile as it approaches the storm center, indicating inflows at ground level characteristic of tornado formation. This information is not available from either the fixed weather stations or the Doppler radar. Automobiles are already equipped with useful temperature and pressure sensors; simple rain and wind sensors could be readily added. Drawing data from the community of millions of vehicles on the road would complement our centralized satellite and ground-based weather data sources, enabling us to forecast development of severe weather and micro-weather with unprecedented accuracy. Image courtesy of Scott Blair, National Weather Service.

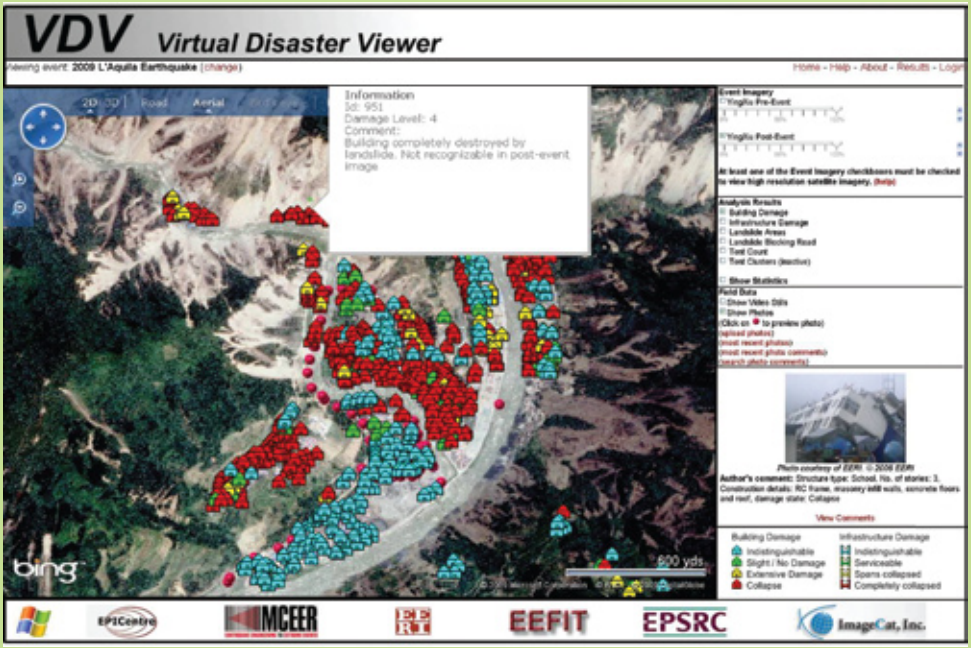


In recognition of the growing importance of community remote sensing through citizen science and social networking to communities around the world, the 2010 annual IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2010), to be held July 26-30 in Honolulu, Hawaii, has adopted the conference theme of "Remote Sensing: Global Vision for Local Action" (www.igarss2010.org). Indeed the conference will begin with a plenary session entirely devoted to the topic of community remote sensing.

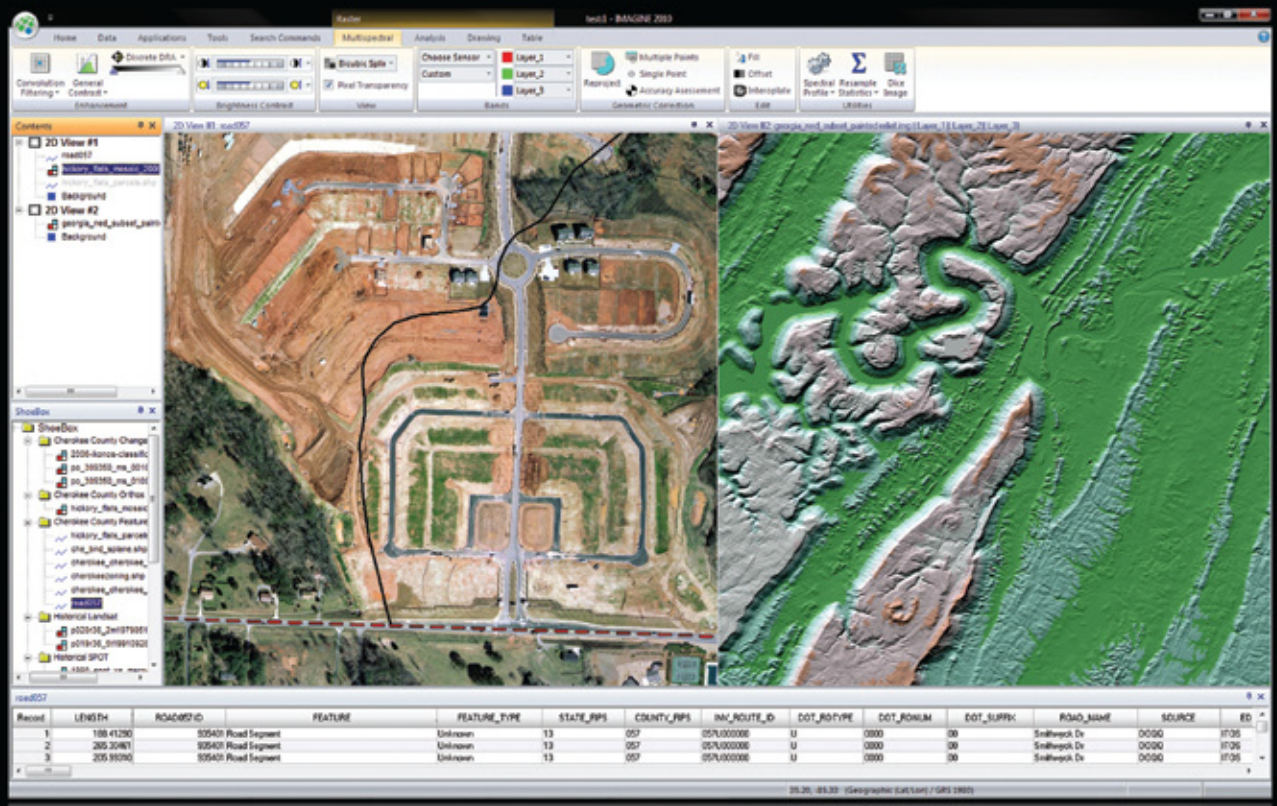
IGARSS plenary organizers are soliciting the participation of organizations that are pursuing projects embodying the plenary theme. They will be looking for projects that demonstrate their promise to create either new knowledge or new technologies associated with community remote sensing. In light of the promise of community remote sensing to improve the delivery of the benefits of space technologies to ordinary people, Secure World Foundation plans to sponsor the IGARSS plenary session.

MORE SOPHISTICATED USES COULD INCLUDE TEMPERATURE AND PRESSURE MEASUREMENTS, ENCODED WITH LOCATION AND TIME COORDINATES, OBTAINED FROM INDIVIDUAL MOBILE PHONES, AND SENT TO A CENTRAL LOCATION TO CONTRIBUTE TO THE CREATION OF HIGH-RESOLUTION WEATHER MODELS OF AN AREA.

Virtual Disaster Viewer



Distributed analysis uses the community to rapidly extract knowledge from raw remote sensing data. This figure shows a software tool called Virtual Disaster Viewer (VDV) developed by the company ImageCat. With VDV, imagery of disaster regions such as earthquakes can be rapidly communicated via the internet to a large network of analysts. These may include known experts, pre-qualified volunteers, or perhaps even anyone who is accessing the internet and is knowledgeable about the affected area. The tool segregates the analysis by grid area to distribute the task and provides a variety of functions to assess the situation and rapidly inform decision-makers of needed actions. The use of community speeds up time-critical tasks that might otherwise take centralized organizations hours or days to complete. Image courtesy of Beverley Adams, ImageCat.



ERDAS IMAGINE 2010

IMAGINE completing your data production projects in a fraction of the time needed today.

IMAGINE having direct and intuitive access to the tools you need, combined with accelerated performance, from a company with over 30 years of experience integrating remote sensing, image processing, photogrammetry, GIS, geospatial analysis and enterprise capabilities.

IMAGINE a single geospatial product that simplifies data exchange, vector collection, map composition, spatial modeling, georeferencing, 3D visualization, mosaicking, reprojection and image exploitation, all while accelerating processing speeds through hardware scalability.

ERDAS IMAGINE 2010 – coming this Fall.

erdas
The Earth to Business Company

Visit labs.erdas.com for a glimpse of ERDAS IMAGINE 2010. For more information on ERDAS, please visit www.erdas.com or call +1 877 GO ERDAS.

The 4th Dimension: Time

Time and Space—the notion of not only mapping our environment, but modeling our environment–is quickly becoming a reality beyond scientific initiatives and science fiction books. In fact, modeling the past, present, and future is helping companies and industries that never considered GIS/Imagery as a source of business context to take a closer look at how location intelligence can make them more competitive, efficient, innovative, and sustainable. Time, in fact, is a hot topic in geo circles, not just from the perspective of integrating the 4th dimension into software applications, but from the perception that it seems to be "speeding up." Globalization, Moore's Law, and real-time communications have all accelerated the pace of change in technology, and in particular the pace of change in technology adoption. Since "time is money," let's look at the impact of time on the I/RS (imaging/remote sensing) business. There are two areas of "time" to consider: Acceleration of Time and Applications Using Time.

ACCELERATION OF TIME

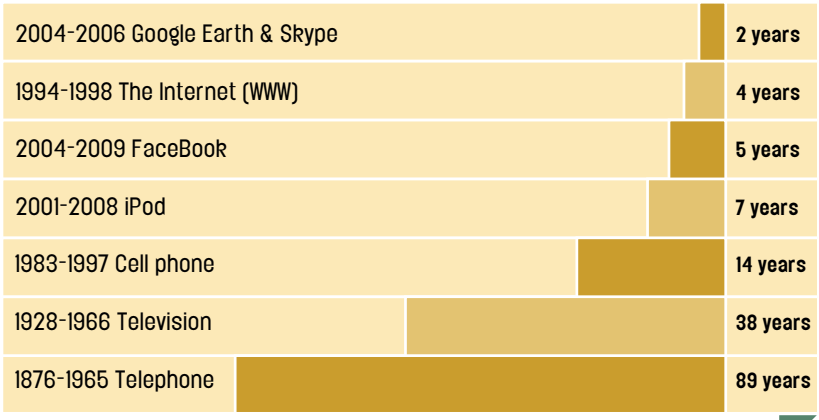
In imagery, we are constantly adapting a five- to ten-year business plan for Earth observation to Earth applications that are changing every day. However, what has not necessarily been contemplated is the speed at which business, consumer, and technology changes would impact the suppliers of geospatial data, technology, and services. This is the entire premise of the geospatial industry–to be able to track the changes on the planet and the changes in physical resources. For example, the "business" and the "business needs" of commercial climate change businesses, green initiatives, carbon credits, hyper-global and hyper-local competition, and 24/7 transactions connecting B2B, B2C, and B2B2C2B market dynamics did not make it into the design and launch plans of satellites, or project-based aerial imagery collection. Five years ago, Google Earth, Bing, SmartPhones and Portable Navigation Devices were not intended to be the most significant distributors of satellite imagery on the planet. The race is on between the Java developers and the mapping professionals. How much faster will changing technology drive new applications to which the industry must adapt?

The timeline of technology and change is finding its way into many presentations lately. Recently we saw presentations by Michael T. Jones, now CTO of Google, and John Stutz of the Tellus Institute at the GeoWeb 2009 Conference noting the exponential pace of technology development, productization, and adoption. Both illustrated how this pace of technology change has significantly increased over the last 10 years and is expected to keep increasing. ***Figure 1*** illustrates the time it has taken for technologies to reach 150 million users. This increase in the rate of change is obviously more difficult to adapt to; in the past, factories had decades to adapt to a new approach, but Google Earth releases new software every Tuesday that is likely to change the way you do business.

We have seen various descriptions of this accelerated rate of change. One of the most interesting is the Mayan calendaring approach, developed approximately 4000 years ago. The Mayans identified a series of foundational layers or cycles that result in increasingly faster cycles of change, each cycle changing

TECHNOLOGY ADOPTION RATE

Time for technologies to reach 150 million users is exponentially decreasing



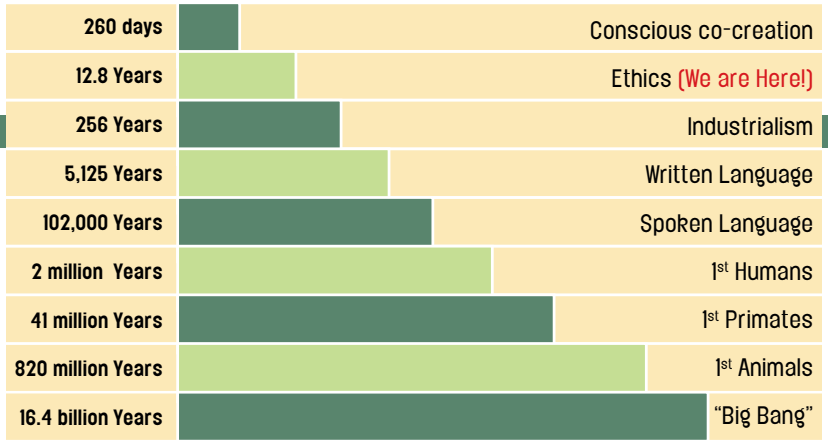
Source: Portfolio Research, ITF Advisors

1

CRAIG BACHMANN & NATASHA LÉGER are partners in ITF Advisors, LLC, an independent consulting firm with a focus on next-generation strategy and on translating the increasingly complex new media business environment's impact on business models, markets and users. Natasha is also editor of the new spin-off publication, *LBx Journal.*

PACE OF CHANGE

The Mayan Calendar



Source: Carl Johan Calleman, *The Mayan Calendar,* (GAREV Publishing International, 2001).

2

20 times faster than the previous cycle. See ***Figure 2*** for the Mayan pyramid of the cycles of change. At present, according to the Mayan Calendar, we are in the 10th year of a 12.8-year cycle of change, which the Mayans predicted as an incredible pace of change that appears to be resulting in scenarios much like what we are experiencing today: product development cycles shrinking, technology adoption increasing, innovation everywhere, real-time communication through social networks – all creating the impression that everything is moving at warp speed.

While the classic Mayan culture may not have had a chance to experience the pace of change they predicted, they appear to have developed a model that explains why the acceleration occurs. The GeoWeb is at the center of this accelerated pace of change because it is the "digital nervous system of the planet," according to Ron Lake of Galdos Sytems, Inc. (Vancouver, B.C.). The GeoWeb contributes to this acceleration of change because it creates a transparent world where disparate pieces of information can be aggregated to present a complete picture of the state of the world, of an industry, or of a business. The integration of time into GeoWeb applications is a critical component.

APPLICATIONS USING TIME

In today's rapidly changing market environment, businesses are looking for answers to basic temporal questions:

- **What is the when and where context for every transaction, location, and event?**
- **When and where is value the greatest?**
- **When and where does my competitor have an advantage?**
- **When and where do I respond to risks and opportunities?**

Integrating the 4th dimension has always been a challenge, but several companies–Myriax, Oculus, Space Time Insight, AGI, and Trinnovations to name a few–appear to be making great strides as they expand the classic GIS "what if" modeling capability into scenario development and forecast modeling tools that serve the needs of everyone from the military to desktop "business" users. These companies appear to be pioneering next-gen temporal GIS and I/RS capability for a wide variety of professional, pro-am (professional/amateurs), and non-technical users.

An entire eco-system of technology for managing libraries of time-sequenced data is moving GIS and I/RS into a next-gen status of providing tools that will help people better understand the impact of technology, location, and behavior on the ever-accelerating pace of change. Look for a detailed article on the 4th Dimension in *LBx Journal*.

◀ **FIGURE 1**
Technology Adoption Rate

◀ **FIGURE 2**
Pace of Change: The Mayan Calendar

THE INDUSTRY DILEMMA

Now that I/RS is part of the digital media distribution ecosystem, as we discussed in our "Price of a Pixel" article in the Spring 2009 issue of *Imaging Notes*, the industry can look at other models for responding to an "on demand" economy. The instinct of most companies during these times of rapid change and uncertainty is to invest in keeping up, or to look for the opportunistic "low-hanging fruit." Keeping up is no longer an option. The issue is how to deploy those "keeping up" resources. Should allocation of resources be in technology development or in how to apply the technology changes to customer needs?

Focusing on the low-hanging fruit may help in addressing quarterly sales quotas, but it is not a recipe for long term sustainability. I/RS technologies will continue to have slower product development cycles than Web 3.0 companies; that is the nature of the I/RS technology. Instead, the focus of I/RS companies should be on accelerating the pace of adapting to customer needs. This includes developing a strategic plan and a set of business policies that enable nimble coordination among conventional enterprise silos (in other words, break down the silos) so that marketing, sales, and product development can respond and adapt to customer needs.

EDITOR'S NOTE

Digital Earth is another way to refer to the concept of the "digital nervous system of the planet." Both the GeoWeb Conferences and Symposiums on Digital Earth discuss the many ways that we can benefit from information that is embedded into a model of the Earth.

Multi-Temporal Remote Sensing

WORKSHOP EMPHASIZES IMPORTANCE OF EARTH MONITORING

EARTH SCOPE

The world took notice this past July on the 40th anniversary of the first moon walkers, Neil Armstrong and Buzz Aldrin. This was truly the biggest step ever recorded for human history. A milestone of this magnitude certainly deserved the media sunshine. Another major milestone for humanity this past July did not receive media attention and clearly deserves to be pushed to the forefront of our civilized minds. Landsat, as a program of continuity for monitoring the whole Earth, is 37 years old and more important than ever.

Change on this planet is happening faster than governments can track and in ways hardly imagined 40 years ago. Human consumerism, consumption, and resource extraction are contributing to accelerating climate change, resulting in profound changes in the ability of nature to provide life-supporting ecological goods and in our ability to provide services.

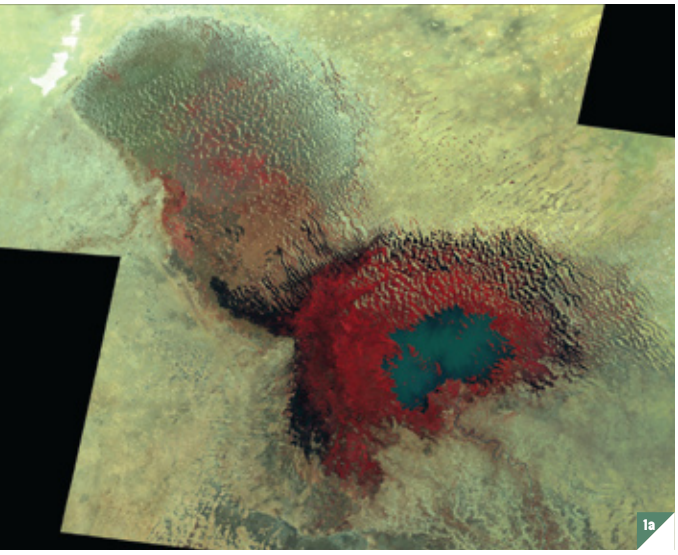
It was therefore a welcomed respite from the summer heat to attend The Fifth International Workshop on the Analysis of Multi-Temporal Remote Sensing Images (MultiTemp 2009) in Groton, Connecticut on July 28-30. The University of Connecticut, under the guidance of Professor Dan Civco, was the host organization, along with NASA, EPA, USGS, IEEE, and CLEAR (http://clear.uconn.edu/multitemp09/). This gathering of international scientists from over a dozen nations targeted the advances and capacity of our technology to conduct change detection and monitoring.

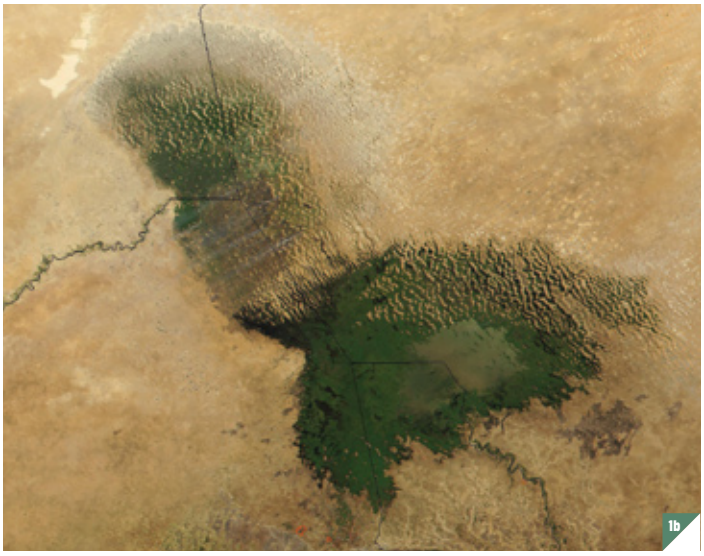
MultiTemp began in September of 2001 at the University of Trento, Italy under the leadership of Professor Lorenzo Bruzonne. At the time, the organizers recognized that the development of effective methodologies for the analysis of multi-temporal data represented one of the most important and challenging issues that the remote sensing community would face at the beginning of the 21st Century. It was surmised by the organizers that relevance and timeliness for upgrading our community's understanding of this issue were directly related to the ever-increasing quantity of multi-temporal data provided by the numerous remote sensing satellites that orbit our planet. They proposed that it would require the synergistic use of multi-temporal remote sensing data and advanced analysis methodologies to address and solve complex problems regarding monitoring of the Earth's surface and atmosphere. MultiTemp has been meeting every two years since, with the sixth in the series, MultiTemp 2011, to be held in the city of its inception, Trento, Italy.

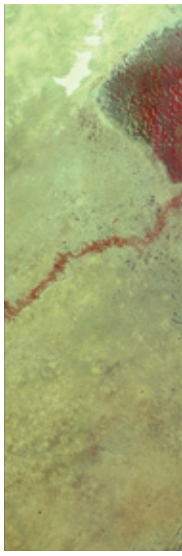
It was fitting that NASA's Darryl Williams kicked off the workshop by looking at the cornucopia of imagery available to today's Earth scientists and by challenging the community to take stock of where we are and where we are going with this surfeit of data. NASA, along with the USGS, has had the longest track record with remote sensing change detection, as used for a plethora of classic examples demonstrating fantastic changes on the Earth's surface. Williams presented examples ranging from the depletion and fragmentation of tropic forest to the desiccation of Lake Chad (***Figure 1a,b,c***), noting that the advent of the Landsat remote sensing data series has been instrumental in chronicling our dynamic Earth.

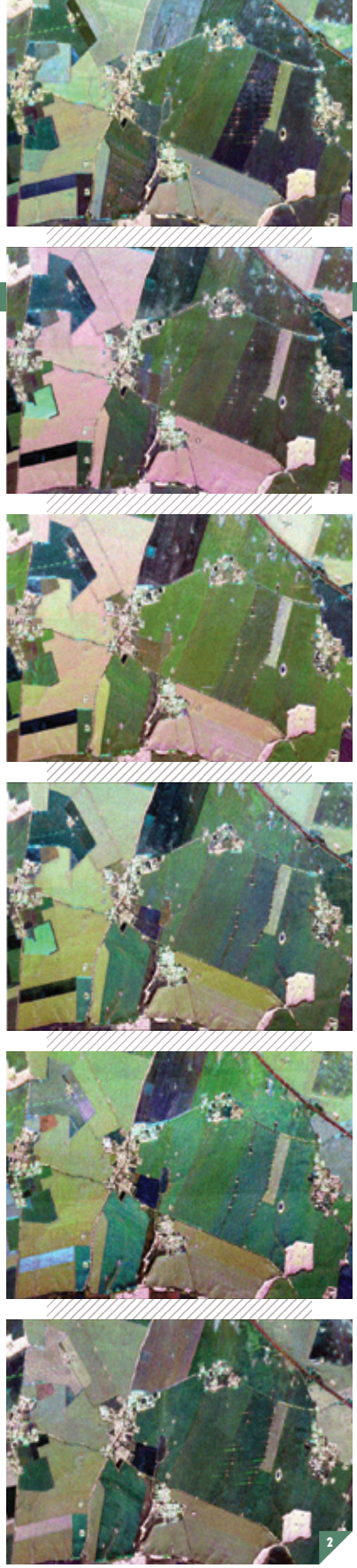
A litany of high-resolution and high-temporal data sets were presented over the three-day workshop, from GeoEye-1 and IKONOS to WorldView-1, that fully demonstrated the power of multi-temporal data analysis for defining key changes in our landscape and environs. Land use and land cover change detection led the program, while vegetation dynamics opened new horizons for

TIM FORESMAN, PhD, is president of the International Center for Remote Sensing Education and can be reached at foresman@earthparty.org.









▶ FIGURE 2
Images illustrate the virtues of multi-date C- and L-band SAR data in agricultural land cover classification, courtesy of Dr. Henning Skriver, Technical University of Denmark.

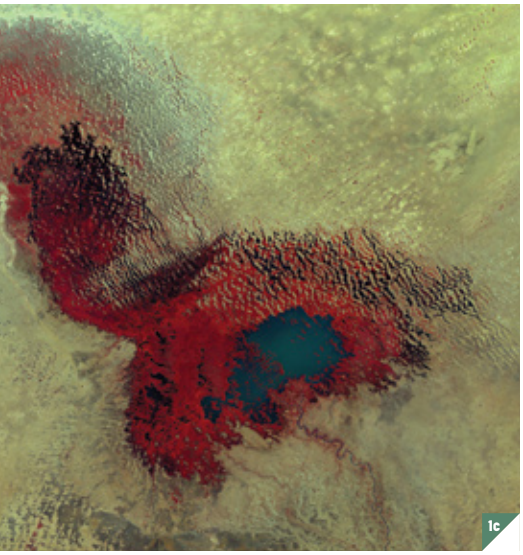
forest chemistry and other biomass indicators critical to our understanding of carbon.

Radar, especially SAR data, is being used more actively for multi-temporal analysis with the advent of multiple platforms for providing data. Scientific applications include monitoring of the cryosphere to help quantify glacier melting around the globe. Significant results include land deformation and subsidence, which are practical problems for major cities depleting their aquifers for an ever thirsty and growing populace. Danish scientists are applying multi-temporal radar for land use classification (***Figure 2***). Most of the major environmental and climatic challenges were addressed in part by the examples provided during the workshop.

However elated I was with the cutting-edge prowess and creativity of these international scientists, I remain concerned regarding the impact of our community's work. What, if any, international treaties are being invoked? How are governments and industry using these data, and communicating to the public and media? How is our 37 years of experience in Earth monitoring changing our K-12 educational settings to address several problems quickly? What exposure to the technology and research findings are university students getting as part of their basic education? I am concerned that we are remote sensing savants with our heads in the clouds and not in the halls of the decision makers or the public venues for the citizens who elect the decision makers.

I sometimes wonder if our situation is akin to looking into the mirror and discerning the telltale signs of aging. As we watch the Earth with our increasing sophistication of innovative analytical approaches, we see Gaia aging and senescing in so many directions. We see evidence of crow's feet creeping along areas of previously verdant, untouched biodiversity now exacerbated by transportation networks fragmenting the landscape, while weather patterns transition to a new climate regime.

We have no cosmetic palliatives to reverse these declines and no international or local consensus has been raised on when we should address this aging phenomena. Aging is, after all, a natural process. But the Earth is an ever-rejuvenating system that is rapidly shifting to a new climate regime, the Anthropocene, a man-made epoch. The application of remote sensing technology and techniques to monitor our affairs and potentially change our governance and commerce patterns presents a very robust and rewarding calling to new and old scientists on our dynamic Earth.



◀ FIGURE 1A
1987 Landsat 5 MSS mosaic of Lake Chad, in west-central Africa, courtesy of USGS.

◀ FIGURE 1B
2001 MODIS mosaic of Lake Chad, courtesy of NASA.

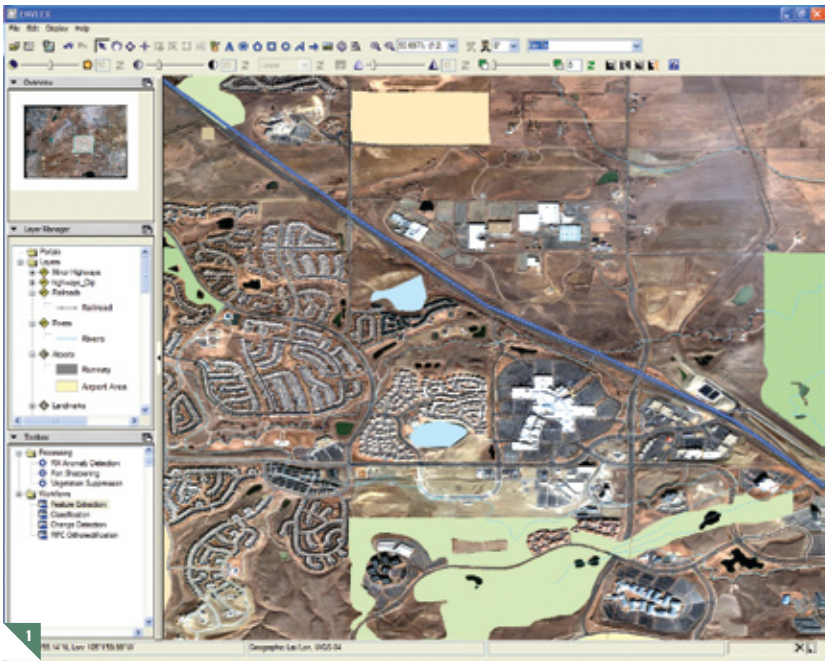
◀ FIGURE 1C
2007 Landsat 7 ETM of Lake Chad, courtesy of USGS.

The Whole World in Your Hands

PUTTING FAST, DYNAMIC IMAGE DISSEMINATION AND ANALYSIS INTO THE HANDS OF GIS ANALYSTS

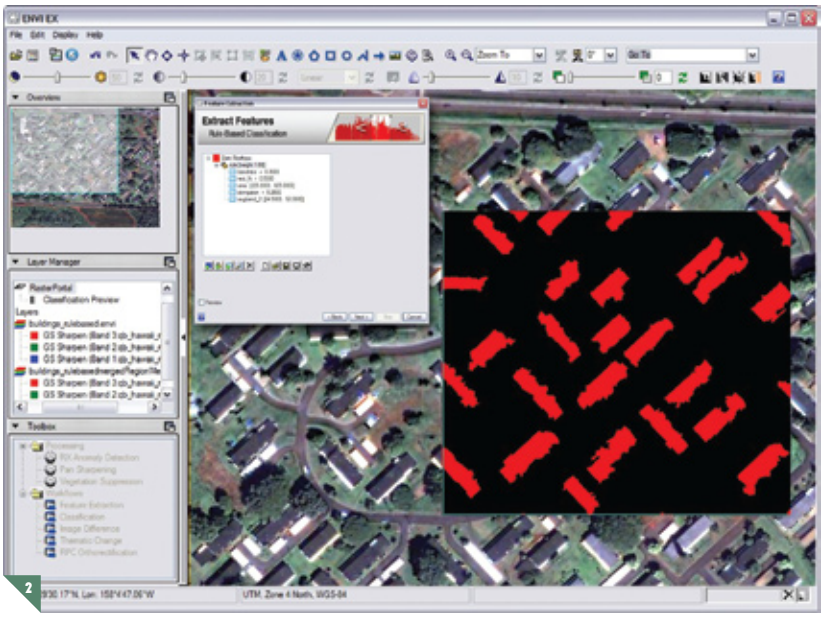
Imagery is a wise investment for any organization looking to use geospatial data. The data can be used for everything from simple visuals, such as ground truthing and change detection, to more sophisticated analyses, including feature extraction and land-use classification. As imagery has become more accessible and more affordable in recent years, there is also a growing convergence of imagery and geographic information systems (GIS) applications. To make the most of the investment in imagery, image scientists and analysts need to be able to easily access imagery and move seamlessly between GIS and image processing applications to derive the most information possible from the imagery and data.

KAREN RICHARDSON
Writer
ESRI, Inc.
Redlands, Calif.
www.esri.com



▲ **FIGURE 1**

ENVI EX from ITT makes it easy for users to seamlessly integrate and analyze data from their GIS. Shown here is an ESRI ArcGIS layer in ENVI EX with all the symbology preserved. This layer can be used in any of the ENVI EX automated analysis workflows in the toolbox.



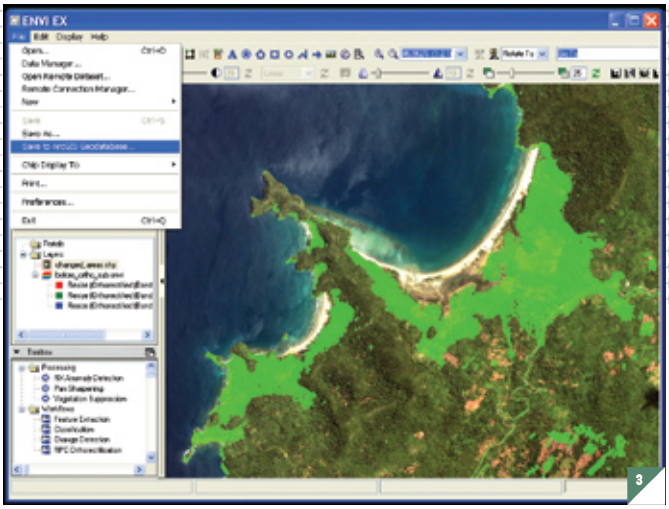
▲ **FIGURE 2**

ENVI EX has a comprehensive array of image processing and exploitation capabilities. Shown here is the beginning of the ENVI EX Feature Extraction workflow, an advanced object-based approach to automatically extract features of interest across an entire image. All feature extraction results can be exported directly into a geodatabase or into an ArcGIS project.

Access and Use Large Amounts of Data

The large volumes of high-resolution imagery available today require organizations to create a strategy for storage and use. ESRI's ArcGIS suite of GIS software provides a high-performance enterprise platform for integrating imagery with other data, including vector maps and georeferenced information.

For data management, including imagery, ArcGIS Server is able to store vast amounts of data in one common location. Adding the ArcGIS Server Image extension provides dynamic mosaicking and on-the-fly processing. By using both ArcGIS Server and the



▲ **FIGURE 3**

ENVI EX includes automated workflows for detecting change over time using imagery taken at different times or with different sensors. In this case, ENVI EX is able to easily identify and export areas with significant changes in vegetation both from manmade features (the road in the lower right) and natural activity (the tsunuami destruction of shoreline). These results can easily be exported to a geodatabase for further analysis and map composition.

ArcGIS Server Image extension, data managers are able to create multiple products quickly from a single source. Imagery can be optimized for analysis and made available quickly after acquisition, all without data duplication. The extensive storage overhead and processing delays previously required when working with imagery are significantly reduced, since only the original set of source imagery is maintained.

How imagery is used in conjunction with other geographic data depends on the problem to be solved. Many different clients can use imagery from ArcGIS Server, including ESRI's ArcGIS software (a wealth of desktop, Web, and mobile applications), as well as products built for specific tasks. For image and geospatial analysts, ENVI software from ITT Visual Information Solutions (ITT VIS) allows traditional image analysis in a GIS workflow. It extends ArcGIS users' capabilities to analyze imagery in both traditional and GIS environments.

Sophisticated Image Analysis for GIS

In the past, image analysis has been perceived to be complicated and generally used by those who are well-versed in the latest spectral image processing and analysis technology. Many image analysis tools have been available for the visualization and analysis of spectral imagery for some time, but the learning curve has often been too steep for many professionals. GIS analysts are traditionally well versed in the analysis of geospatial information but have often used imagery only as a backdrop or for hand-digitization purposes to update data layers in a GIS.

> "FAST, DYNAMIC IMAGE DISSEMINATION AND ANALYSIS HAVE COME OF AGE."

Recently, there has been a move in the remote sensing software world to provide tools and workflows that are beneficial to GIS analysts who are looking to imagery for new ways to add timely, meaningful information to projects. In light of this growing trend, ESRI and ITT VIS have worked together to integrate their respective software technologies, ArcGIS and ENVI, to meet the need for adding imagery to GIS workflows.

This ArcGIS and ENVI integration opens up the world of image analysis. "The relationship between ITT and ESRI is making it much easier for users to combine GIS and imagery in order to make authoritative decisions," says Lawrie Jordan, director of enterprise image solutions, ESRI. The integration of the ITT and ESRI technologies is now available in ENVI 4.7 and a new product from ITT designed specifically for GIS professionals called ENVI EX.

The new integration allows users to exchange data and files from ArcGIS to ENVI easily with simple drag-and-drop methods that preserve the style, symbology, vectors, and layer information from one interface to another. ArcGIS workflow integration and map generation capabilities are now also available from within ENVI products.

In addition to the integration with ArcGIS, ENVI EX also provides new users with access to the methods and algorithms that image scientists have been using for

> ENVI EX PROVIDES AUTOMATED WORKFLOWS FOR SOLVING PROBLEMS THAT ARE COMMON IN GIS APPLICATIONS ACROSS A VARIETY OF INDUSTRIES, INCLUDING THE EXTRACTION OF FEATURES OR OBJECTS FROM IMAGE DATA, DETECTION OF CHANGE OVER TIME, AND CLASSIFICATION AND MAPPING OF IMAGE DATA.

years in automated workflows that don't require the traditional steep learning curve. The ENVI EX interface is easy to use and guides users through the analysis of satellite and airborne imagery in a step-by-step manner. ENVI EX provides automated workflows for solving problems that are common in GIS applications across a variety of industries, including the extraction of features or objects from image data, detection of change over time, and classification and mapping of image data.

Increased Productivity and Accuracy

"Our development of ENVI EX and the integration with the ESRI platform has allowed us to simplify imagery analysis without compromising the accuracy of the results," says Richard Cooke, president, ITT VIS. "And, the ability to find and identify features in imagery allows users to get meaningful and timely information from imagery quickly and easily."

To save valuable time processing and reprocessing entire image scenes, interim results in ENVI EX workflows can be fine tuned with the help of a preview window that gives on-the-fly results during each stage of the workflow before processing even begins. The workflows also allow the user to move back and forth between each step, allowing modifications to previous steps that may not have been apparent at first.

Tools and workflows are also available to simplify the visualization and interpretation of image data. For example, the GeoLink to ArcMap feature in ENVI EX allows users to simultaneously pan and zoom around an image with side-by-side windows of ArcGIS and ENVI EX, making image analysis more efficient and productive, particularly when trying to verify the accuracy of information of a certain location between applications.

Integrated workflows that focus on ease of use save organizations time and money by allowing users to get up and running quickly and by providing accurate results. Image analysis workflows are available in application areas that are important to GIS professionals and can be used to solve common problems across government, mapping organizations, oil and gas, agriculture, asset management, and many other industries.

Data Support and Interoperability

Data support is key for image analysis, as there are many different types of data available from satellite and airborne sensors, including panchromatic, multispectral, hyperspectral, radar, thermal, lidar, and more. It is important that image analysis applications support the wide variety of data types available so that the user has access to the imagery sources possible for a particular project.

ENVI EX supports ArcGIS image services, as well as more than 70 data formats including J2K, GeoTIFF, and optional JITC-compliant NITF data. Image services incorporated in ArcGIS Server also support a large range of Web standards including WMS, WCS, KML, SOAP, and REST. These types of data support and interoperability allow users to be more efficient and effective when incorporating imagery into their workflows.

ESRI AND ITT PARTNER

ITT VIS and ESRI have created a transactional platform that allows users to fully exploit imagery. The ability to apply complex image analysis to the vast amounts of imagery available makes imagery applicable to any geospatial workflow. ArcGIS and ENVI EX bring the image management, processing, and analysis necessary to handle complex modeling and to incorporate hard science into everyday tasks. Fast, dynamic image dissemination and analysis have come of age. For more information, visit www.esri.com/imagery or www.ittvis.com/envi.


BUILD

IRAQI GEOINT

NGA DEPLOYMENT

Imaging Notes interviewed an NGA Staff Officer and a Canadian Army Lt. who voluntarily deployed to Iraq in support of the creation of their Imagery and Mapping Directorate. We asked about their mission, their use of imagery, and their deployment.

IMAGING NOTES Please describe your mission and your role for this deployment.

GREG I was a National Geospatial-Intelligence Agency (NGA) employee augmented as an Advisor to the Multi-National Security Transition Command-Iraq (MNSTC-I). Our mission was building, equipping and training the Iraqi Security Forces (ISF) for the security and sustainment of Iraq. My role, along with the others on my team, was to provide support to MNSTC-I and to the Iraq Ministry of Defense (MoD) by supporting the Iraqi Imagery and Mapping Directorate (IMD). While living and working in the International, or "Green" Zone in Baghdad, Iraq, I saw first-hand the sacrifices that the men and women of our Armed Services are making to accomplish their missions.

GREGORY M.
National Geospatial-Intelligence Agency
U.S. Department of Defense
www.nga.mil

LT. PAUL MACKENZIE
Canadian Forces
Department Of National Defence
Government of Canada
www.forces.gc.ca

◀ FIGURE 1
This satellite image of Baghdad was taken by GeoEye-1 on Aug. 30, 2009, just a few months ago, and is courtesy of GeoEye. The Tomb of the Unknown Soldier is in the lower right of the image.

PAUL I was on exchange with the U.S. Army 18th Airborne Corps for three years and deployed to Iraq with them. About half-way through my tour, an opportunity arose to assist Imagery and Mapping Directorate (IMD). I was the Geospatial Operations Officer for 18th Airborne Corps in the Engineer shop (C7) at

the time. I saw the level of products they were producing and wanted to help reinforce their success. I visited IMD to see where they were and was very impressed at how far they had come in so little time. I immediately petitioned my supervisor to allow me to help out.

IMAGING NOTES With whom did you work, and at what level?

GREG I reported to my NGA Country Lead in Iraq and the MNSTC-I Leadership. On a daily basis I worked with all the United States and Coalition Military Services to the rank of Brigadier General, Senior Executive Service Level 1 (Brigadier General equivalent) and other government agencies' civilian and contract employees. I also worked daily with Iraqi civilians and Iraqi Army soldiers and officers to the rank of Major General at IMD and the MoD.

PAUL I was embedded with an NGA team. My primary focus was consolidating the data and encouraging the networking of systems — the technical aspects.

IMAGING NOTES What was it like working directly with the Iraqis?

GREG In a word, rewarding. Working directly with the Iraqis was quite honestly a pleasure. I found them to be diligent workers for the success of the Government of Iraq. They had passions for life, food and family. Business meetings generally began with drinking chai and catching up on family and life matters. It was an adjustment because, as Americans, when on the job we feel that we have to be productive every moment. With the Iraqis, first building the relationships and trust would lead to greater future success with the mission.

PAUL Working directly with the Iraqis was a very rewarding experience. They were very friendly and quickly warmed to you. Every day we would have some chai and get to know them a little bit more. There was great importance placed on learning and they had pride in their work.

IMAGING NOTES What sort of training do the Iraqis get in geospatial matters?

GREG Several of the Iraqis were in the former regime's Military Survey section. At that time they were using aerial photographs collected by their aircraft to build topographic line maps, so those who had served in the former regime's Military Survey section had a strong background in geospatial and photo interpretation. The others at IMD had varied educational backgrounds, such as Computer Science, Engineering and even Arabic language. These employees received training in vendor software packages, such as ESRI's ArcInfo and BAE Systems' SOCET Set, and GEOINT training that was provided by NGA.

In addition, with the assistance of the coalition, the Iraqis established the Intelligence and Military Service School, which was responsible for training the ISF with more in-depth tiered training in particular disciplines. NGA assisted with a "train the trainer" concept to develop and teach Advanced Geospatial and Imagery Analysis courses.

PAUL The U.S. Engineers and Intelligence Transition Team provided excellent training. Many of the senior staff of IMD were former army engineers who had survey and geospatial training. The 100th Engineer Company set up training in Belad from scratch to instruct the Iraqi Army as well.

IMAGING NOTES Do their ministries cooperate in using remotely sensed data?

GREG Yes, the ministries were using commercial imagery acquired through NGA by IMD. IMD was the central repository for the imagery, and the other ministries, such as the Ministry for Water Resources and the Committee of the Census under the Ministry of Planning, were using the data for civil purposes. IMD supported both the military and the civil ministries; they were the GEOINT provider for Iraq. In addition, the Iraqis had organic airborne collection platforms that were being tasked by the Iraqi Army, Air Force and IMD, to name a few.

The Iraqis wanted to establish a GIS "Center." We had this discussion only conceptually and only within the MoD, but the intent was to have a ministry responsible for housing all geospatial data. The focus would be to have a standard and updated dataset available to all users. IMD should be the owner of the dataset and be responsible for managing the data, with updates coming from all ministries, services and GIS professionals.

PAUL There was a lot of cooperation between the ministries, and IMD supported everyone they could. In fact, seeing the success of interagency cooperation as well as interoffice harmony was one of the reasons I wanted to help out. I knew there were Arabs and Kurds as well as Shias, Sunnis, and Christians all working together — women and men worked alongside. With a few exceptions, it was an average multicultural office you might expect to see in Toronto.

▼FIGURE 2
This palace in Baghdad's International Zone was reportedly built for Saddam Hussein's daughter.

IMAGING NOTES Do you think that you got proper training for your deployment?

GREG Yes, NGA prepared me quite well for my deployment. Because this was such a unique role, I suggested additional training, such as working with an interpreter, and a cross-cultural communications course. The organization that I came from here at NGA allowed me to take several courses that prepared me for this role. We received GEOINT training on products and software, customer relations, first aid, weapons qualifications and driving skills.

However, the biggest preparation for all deployers is from a personal perspective — that is, to have a positive attitude and realistic expectations while being in a war zone. It's very important to listen, observe and adapt when you first meet your counterparts, and use a phrase or greeting in Arabic.

PAUL My pre-deployment training was comprehensive, and included combat-focused training.

IMAGING NOTES How often and for what purposes would you leave the Green Zone and travel into the Red Zone? What was that like?

GREG We travelled daily around the Green Zone in an armored vehicle to an Iraqi Camp, the MoD, other FOBs (forward operating bases), and often to the U.S. Embassy in Baghdad. We were permitted to travel into the Red Zone only with a convoy, and I did so to travel to the Victory Base Compound near the Baghdad International Airport (BIAP).

When travelling in the Red Zone, we were required to wear our Kevlar (Helmets) and IBA (Individual Body Armor). It was interesting to see the beautiful architecture, the Mosques, and the Iraqis going about their daily business. We also traveled via helicopter to other locations flying relatively low so we gained a great perspective of the landscape.

PAUL My primary place of work was on Camp Victory located near BIAP. When I started to work with IMD, I would commute every Sunday morning through the Red Zone to work in the International Zone (Green Zone). At the end of the Iraqi work week on Thursday evening I would commute back to BIAP.

After the first few times it was like any other commute on the Rhino or MRAP. Truth be told, I'd rather drive through the Red Zone from BIAP to the Green Zone than have to suffer the Washington D.C. beltway.

IMAGING NOTES How important is it that those who are deployed understand their culture?

GREG It varies. In my role, it was more important than in other roles. However, the leadership and employees at IMD were very receptive to the advisors sent by NGA. The deployers who preceded and followed me were high caliber GEOINT professionals with years of experience. To IMD, the consistency that NGA provided in GEOINT professionals was very welcomed and more important than understanding their culture. I did, however, make every effort I could to learn from the Iraqis and participate in their customs to make the relationship and trust much stronger.

PAUL It is extremely important to understand a culture if you want to make any lasting change or to identify what needs changing. It's easy to show up in any organization and offer advice on how things should be done. It's much more challenging to understand why things were done. Trying to understand a culture is also a simple and effective way to show respect.

◀ **FIGURE 3**
The Tomb of the Unknown Soldier is in the International Zone (Green Zone). Its restoration was unveiled in January 2006. The monument was originally built by Saddam Hussein's regime. It is said to have been inspired by the glorification of a martyr from the Iran-Iraq war (1980-1988).

▼ **FIGURE 4**
This monument, called Crossed Swords, is a triumphal arch built to celebrate "victory" over Iran in 1988. It was made from the guns of dead Iraqi soldiers that were melted and recast as the 24-ton blades of the swords. This area of Baghdad, with the Crossed Swords and Tomb of the Unknown Solder, was a military exercise area where Saddam Hussein reviewed his troops.

IMAGING NOTES Which aspects of their culture did you most appreciate and enjoy?

GREG I enjoyed starting business with chai or Arabic coffee and conversation about family and friends. At IMD the leadership had a good sense of humor. A joke or amusing anecdote was always welcome, especially when we were having a difficult or stressful week. I also enjoyed being called into one of the offices where a group would be gathered to share a dish that one of their family had prepared.

PAUL The food, personal warmth and the language! We had several opportunities to eat local food with IMD staff. I started to learn Arabic, as well.

IMAGING NOTES What was the best thing about your deployment?

GREG From a professional perspective, the best thing was supporting the warfighter and our partners, and assisting in building the ISF. When I first arrived at MNSTC-I, the Army Colonel to whom I reported would tell us, "You're making history." I pondered that for awhile, and one day when a significant IMD initiative came to fruition, I believed it!

From a personal perspective and as a geographer, I was excited about learning the Iraqi and Arab culture. As I was told, an Arab tradition is providing a guest with more food than you could possibly eat. As I was preparing to leave Iraq, this honor was bestowed upon me, and as I looked out over a table filled with traditional Arab fare, I looked around at the faces in the room, and I felt truly honored to be in their company, in their country.

PAUL The best thing about my deployment was being able to work with this NGA team. We have NGA reps in Canada, but I've never worked with them before. Since I became the

recipient of NGA support from Ft. Bragg to Baghdad, my respect for them has grown. I was lucky enough to be the first foreigner in a GST (geospatial support team). I really grew to admire NGA as an organization, seeing how focused they are on serving the people they consider partners.

IMAGING NOTES What was the most challenging thing?

GREG The living quarters and conditions of living on an FOB was challenging — not that they were bad, but the close proximity was challenging. I put it all in perspective, though, when I'd see the soldiers return to the base after a patrol. They were dirty and tired and would remove their Kevlar and IBA and catch a quick nap in the shade of their Humvee or MRAP (mine-resistant ambush-protected) vehicles. I really couldn't (and didn't) complain!

PAUL The most challenging thing was being away from my wife for 13 months. She's the better part of me. Strangely, the next most challenging thing had to be going back home before things were complete. I tried unsuccessfully to stay in Iraq for an additional six months. It was with great sadness that I left my friends in the IMD. I fell into a bit of a slump after I came back.

IMAGING NOTES Do you think that you are changed from this experience, and if so, how?

GREG Of course. To be immersed in this culture where my only previous images were through the media brought to me a better understanding of the Iraqi's daily struggles, their religion, family values and perseverance. To hear their perspective of how they felt the government was operating, something unheard of until recently, the harsh stories of the Saddam regime and how this war had affected them personally, all widened my perspective.

PAUL I grew from the experience by being one of a handful of Canadians. There were other Canadian officers there (general staff planners, squadron commanders, JAG advisors and a pilot with the Marines) but for the majority of the time we did not interact. So you have to grow and learn more about yourself.

IMAGING NOTES Will you be deployed again, and if so, why?

GREG Yes, I will re-deploy. I'd always been in the rear supporting the warfighter and humanitarian operations at NGA. However, to be up front and really feel like I was making an immediate difference was very rewarding and personal for me. Hearing the service members and Iraqis say, "thank you for your support" made it all worthwhile for me!

PAUL I will be deployed again. There's no question about that, although next time it will probably be to Kandahar, Afghanistan. Canada has approximately one-third of its combat forces deployed there and we as GEOINT Analysts are always in high demand. As a soldier I'm looking forward to an opportunity to work alongside NGA and the U.S. Army again.

EDITOR'S NOTE

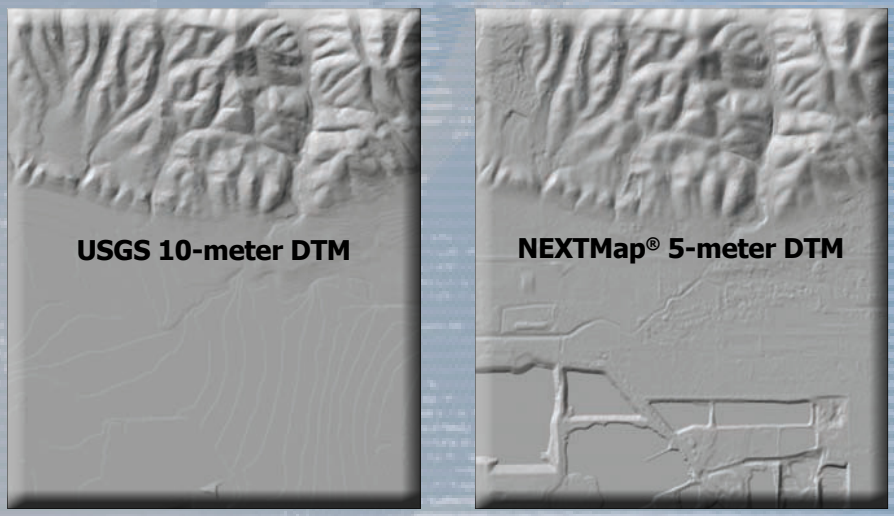
All photos are courtesy of Gregory M. of NGA. No sample product imagery was available due to the sensitive nature of the missions.

INTERMAP TECHNOLOGIES

NEXTMap® USA ... When Free Just Isn't Good Enough

Intermap's uniformly accurate and reliable NEXTMap® USA 3D digital elevation models and images:

- Coast-to-coast coverage in early 2010
- Precision data for majority of states and counties available TODAY!



Shaded relief models comparing a free USGS DTM and a NEXTMap® USA DTM.

Visit intermap.com/nextmap-usa to learn more about NEXTMap® USA and download sample data.

0909IN

Imagine what you could do if adding information from geospatial imagery to your GIS was easy and convenient. Now it is. Introducing ENVI EX, software developed specifically to help you unlock the information in geospatial imagery to enrich your GIS. ENVI EX is seamlessly integrated with ArcGIS® to fit easily into your existing workflow. And, revolutionary step-by-step processes guide you through advanced image processing tasks, so you can achieve the expert level results ENVI is known for. ENVI EX – accurate geospatial information for your GIS, now made easy.

Easily unlock the information in your imagery – ENVI EX.

ITT

Engineered for life

ENVI EX

Communications • Sensing & Surveillance • Space • Advanced Engineering & Integrated Services

ITT, the Engineered Blocks, and "Engineered for life" are registered trademarks of ITT Manufacturing Enterprises, Inc., and are used under license. ©2009, ITT Visual Information Solutions

Remote Sensing by Remote Control

UAVs BECOME INVALUABLE ASSETS

▲ FIGURE 10
Electrical tower nest shown with MicroPilot's CropCam.

MATTEO LUCCIO
Writer
Portland, Oregon
www.palebluedotllc.com

When Somali pirates hijacked the U.S. freighter Maersk Alabama and took Capt. Richard Phillips hostage in April, a U.S. Navy ScanEagle unmanned aerial vehicle (UAV) built by Boeing's Insitu unit took video footage of the developing situation. Predator and Reaper UAVs have been in the news recently because the U.S. military has used them to launch missile strikes, such as the one that reportedly killed Osama Bin Laden's son, against Al-Qaeda and Taliban targets in Afghanistan and Pakistan.

Less publicized is the extensive use of UAVs by the U.S. military for "dull, dirty, or dangerous" surveillance tasks for which they are better suited than piloted aircraft. Real-time images and videos are increasingly used for remote surveillance, intelligence gathering, situational awareness, and decision-making. "At the receiving end, the amount of data available is increasing exponentially," says Kevin Kelleher, airborne integration lead for the National System for Geospatial Intelligence (NSG) at the National Geospatial-Intelligence Agency (NGA).

By associating geospatial information with imagery intelligence, this airborne video surveillance (AVS) technology allows decision makers to view developing situations in their geographic context, track and visualize events as they unfold, and predict possible outcomes.

"THE MQ-1 PREDATOR, ARMED WITH THE AGM-114 HELLFIRE MISSILE, CONTINUES TO BE ONE OF THE MILITARY'S MOST REQUESTED SYSTEMS."

What UAVs Are and What They Do

Also known as remotely piloted aircraft (RPA), unmanned aerial systems (UAS), and simply drones, these remotely piloted fixed- and rotary-wing aircraft and lighter-than-air and near-space systems are both armed and unarmed. They range in size from hand-launched models that look like toy planes and can weigh as little as 12 pounds to the jet-powered RQ-4 Global Hawk, built by Northrop Grumman Aerospace Systems, which has a 3,000-mile range and operates at about 60,000 feet, and the MQ-1 Predator and MQ-9 Reaper, both built by General Atomics Aeronautical Systems.

The Predator, which can fly at altitudes of up to 25,000 feet, performs surveillance and reconnaissance missions and carries two laser-guided anti-tank Hellfire missiles; it can stay in the air for about 40 hours. The Reaper is a larger and more capable aircraft that can fly at 50,000 feet, carrying up to 14 Hellfire missiles, and using infrared sensors to distinguish the heat signatures of rocket launchers, anti-aircraft guns, and other firepower on the ground.

Today, the U.S. military deploys more than 5,000 UAVs, and daily UAV missions in Iraq and Afghanistan have nearly tripled in the past two years. Military applications include peering over hills or buildings, monitoring the seas, eavesdropping from high altitudes, and assisting in special operations. The U.S. military also uses UAVs to transmit live video from Iraq, Afghanistan, and Pakistan. Traditional roles for military airborne geo-intelligence, Kelleher says, include operational support, battle damage assessment, treaty/inspection monitoring, non-combatant evacuation operations, forensic analysis, and coalition operations; new roles include disaster relief, counter-terrorism/narcotics, and homeland defense.

Direct connection between UAVs and operators on the ground or on aircraft is limited to line-of-sight communication; however, communication relay nodes and satellites enable operators to control UAVs and download data from anywhere.

History of Military UAVs

The first operationally significant U.S. Air Force UAV program was the Lightning Bug, which was routinely used for tactical reconnaissance during the Vietnam War. Israel developed various UAVs in the 1970s, successfully deployed them in the early 1980s, and then began selling them to the United States, which also began to develop new systems such as the Predator.

The United States used UAVs for reconnaissance during the Gulf War, but it was particularly in the skies over the Balkans, Afghanistan, and Iraq that they proved their worth as an intelligence, surveillance, and reconnaissance (ISR) platform. In Kosovo, commanders deployed the Global Hawk in combat, where they were reluctant to risk piloted U-2 spy planes. According to a U.S. Air Force report, "The MQ-1 Predator, armed with the AGM-114 Hellfire missile, continues to be one of the military's most requested systems."

In Afghanistan and Iraq, small man-portable, low-altitude, short-range UAVs—including the RQ-11 Raven (weighing only 4.2 pounds), the Pointer, and the Force Protection Aerial Surveillance System (FPASS)—have also played important roles by assisting in providing base security, force protection, reconnaissance, and targeting. Recent advances in sensor miniaturization, electro-mechanical control, aerospace design, and wireless video communication have enabled the production of these micro-UAVs, which are much cheaper and quicker to deploy than traditional ones.

Advantages of Using UAVs for Remote Sensing

For both civil and military missions, UAVs have two key advantages over piloted aircraft. First, they are more efficient because they can be designed without regard to human-factor limitations. Second, while they cost about as much per pound as piloted aircraft, they have much lower life-cycle operating and maintenance costs.

From a military perspective, UAVs are "just another source of geo-intelligence data," says Kelleher. However, four advantages have made UAVs more feasible and attractive to military planners.

First, technological advances have made sensor and weapon payloads smaller, lighter, and more capable and have greatly increased the bandwidth connectivity of the data links used for vehicle command and control, payload command and control, and data transfer. Advances in microprocessor technology and software development have enabled onboard processing of sensor data, while advances in inertial and GPS navigation

"TODAY, THE U.S. MILITARY DEPLOYS MORE THAN 5,000 UAVS, AND DAILY UAV MISSIONS IN IRAQ AND AFGHANISTAN HAVE NEARLY TRIPLED IN THE PAST TWO YEARS."

1

have enabled robust autonomous flight control systems. New composite materials and improved propulsion systems have resulted in lighter, smaller, and more stealthy airframes.

Second, UAVs are particularly appropriate to the challenges of "asymmetric warfare" against non-state actors. They can operate in "dirty" environments, such as those contaminated by chemical, biological, or radioactive agents. The endurance of large UAVs provides sustained support for "dull" missions requiring greater persistence than that provided by manned aircraft, such as monitoring conditions that rarely change and reporting only items that need attention. Small, quiet UAVs can get close to a target and provide a bird's eye view.

Third, UAVs with endurance that exceeds human limitations allow commanders to reduce the number of sorties, which translates into fewer flight hours lost due to transit time, less wear and tear on the vehicles, and a sharp drop in the number of accidents. Remote control of UAVs also allows crews to fly operational missions without deploying forward. This reduces support costs and force-protection requirements.

Andrew Carryer, a systems engineer at MDA Corporation (Richmond, B.C., Canada), with the UAV Heron (see ***Figure 1***), points out that the key advantages of UAVs for remote sensing are the time on target, for the military, or the ability to dwell over an area of interest, for civil applications; the ability to quickly re-task the asset to capture fleeting events; and the ability to provide a real-time data feed. Additionally, unlike satellites, piloted aircraft and UAVs can tailor their approach to each target, in terms of altitude, angle, etc.

Fourth, UAVs are much quieter than piloted aircraft, according to

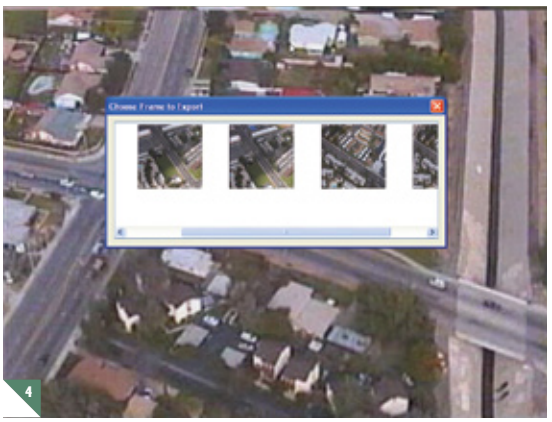
▲ FIGURE 1
MDA Corporation's Heron UAV is a Medium-Altitude Long-Endurance System.

Vern Rummel, a UAV expert with BAE Systems' Unmanned Aircraft Programs (formerly Advanced Ceramics Research). "Targets have no idea that they are being tracked or imaged," he says. In addition, Carryer points out that UAV image interpreters and analysts can be anywhere in the world.

UAVs are not an alternative to piloted aircraft and satellites for reconnaissance but a complementary tool, according to Carryer. "Each one brings unique capabilities," he says. "Cross-cueing allows you to bring a full complement to bear." The trade-off between satellites and aircraft, whether piloted or not, is coverage versus resolution. Satellites provide greater coverage, while aircraft collections provide higher resolution.

◀ **FIGURE 2**
Basic interface of BAE Systems' SOCET GXP Video Analysis software (shown in Figures 2-6).

◀ **FIGURE 3**
Selected regions for editing in the Video Analysis software.



◀ **FIGURE 4**
This image shows the active film roll window.

◀ **FIGURE 5**
This shows enhancements applied.

◀ **FIGURE 6**
Video Analysis software allows tracking a vehicle.

Challenges of Using UAVs for Remote Sensing

Military UAV operators, according to Carryer, face two major challenges: adequate access to air space and to radio frequencies. These, of course, are political, legal, and administrative issues, not technical ones. "Frequency allocation in a congested area is a big deal," says Carryer. "Typically, the people who manage frequencies are not associated with aviation safety. Now a UAV is connected to the ground via a data link, and there are safety issues."

While stabilization is a trivial issue for large UAVs, which use the same gyro-stabilized turrets that are mounted on airplanes and helicopters, it is a major challenge for micro-UAVs. These are bounced around by wind and turbulence much more than larger or faster aircraft, Carryer says. Paul Moller, president of Moller International, Inc. (Davis, Calif.), agrees. The key, he says, is to minimize the vehicle's attitude, rate of angular velocity, and angular acceleration — which requires "very sophisticated power control and millisecond reactions." Turbulence is more related to the design of a vehicle than to its flight speed, points out Scott Newbern, Raven project manager at AeroVironment, Inc. (Monrovia, Calif.). "Our small vehicles tend to operate at 500 feet above the ground, so they encounter more turbulence and changes in the wind than UAVs flying at much higher altitudes," he says. "We can get around the shaky video problem through digital stabilization, gimbals, and software tools to stabilize images." As for the ability to track moving objects, according to Carryer, the only challenge is clouds.

Trade-Offs Between Large and Small UAVs

Large UAVs can fly much faster and for much greater distances than small ones and can carry weapons. However, they compete for transport space with other assets, such as tanks, forcing planners to make difficult choices, says Rummel. Small UAVs, he points out, can easily be loaded into the back of a light armored vehicle (LAV) and can be launched off the ground or from a weapons mount. Designed exclusively to provide aerial reconnaissance for situational awareness, small UAVs enable companies and platoons, for example, to look over a hill for ambushes or IEDs without having to call for a higher level asset, such as a Predator, according to Newbern. They are a force multiplier, he explains, that allows them to perform missions that otherwise would take a much larger force.

The Role of the NGA

While the NGA does have a significant role in exploiting geo-intelligence data, most of the first level of exploitation is done by the military in the field, Kelleher explains. However, the services expect the NGA to store the data and to make it available for future use. ("You guys are storing all this stuff, right?") UAVs are in part responsible for the huge growth in the amount of geo-intelligence data collected. The director of NGA sees these data as so important that he appointed a Deputy CIO for Data, Jack Hill. "The analytic resources are limited and the source data is exploding much faster than our ability to exploit it," says Kelleher. "That is why it is important for us to continue to promulgate standards."

Data Standards

In order to plug into the existing communications architecture wherever they operate, UAVs must use data standards. NATO, for example, has standards for the formats of still images (STANAG4545, similar to JPEG) and of video streams (STANAG4609), as well as for communications and data links. Within NGA, there are currently three major working groups in place to address standards: the Geospatial Intelligence Standards Working Group, the NGA Interoperability Action Team, and the NGA Standards Board. There are also four chartered focus groups made up of subject matter experts: the National Imagery Transmission Format Standards Technical Board, the Motion Imagery Standards Board, the Community Sensor Model Standards Working Group, and the Metadata Focus Group.

Last summer, President Bush revised Executive Order 12333, which regulates U.S. intelligence activities, to make the director of the NGA the functional manager for geo-intelligence. The NGA does not own or operate any aerial intelligence collection platform, Kelleher says. The agency's role "is not as much about controlling the activities as about leading them and providing oversight," he says. The NGA director is also responsible for defining geo-intelligence data standards and tweaking them as the technology advances.

7

8

◀▲ **FIGURES 7-8**
MicroPilot images for farming from the UAV CropCam include this stitched image of British Columbia (above), taken from an elevation of 2,100 feet, and the NW Quarter of a zero-till farm (left).

Video Analysis Software

One of the most valuable products that UAVs can provide is streaming video, in real time or near real time. This product also poses one of the greatest challenges. "To be useful, this massive amount of data must be analyzed in near real time," says Matt Bower, of BAE Systems (Rockville, Md. with headquarters in San Diego, Calif.), a subject-matter expert for the company's SOCET GXP Video Analysis software tool. The very flexible and dynamic re-tasking of UAVs, he points out, requires analysts to quickly analyze the data stream, which can be part of live operations.

SOCET GXP, he explains, can take in video from UAVs—plus a stream of support data that includes such variables as the platform's location, its look angle, the temperature, and the wind speed—and display the footprint of the camera's field of vision on a map. The user can then move the frames of interest into SOCET GXP to create annotations, mark-ups, briefing products, terrain extraction, building extraction, and so on. "You now have all the SOCET GXP functionality in the video," says Bower, "and can push the data through. You can fuse the video with other reference sources you might

◀ FIGURE 9
Beaver dam shown with MicroPilot's CropCam.

Civilian Applications

Civilian applications of UAVs range from monitoring crops, weather, coast lines, and borders to surveying crime scenes, assisting in search and rescue operations, and exploring for minerals. Some companies specialize in the production of relatively cheap UAVs for these civilian applications. MicroPilot (Stony Mountain, Manitoba, Canada), builds UAVs that cost less than $7,000 and do not require trained pilots to fly them. According to Pierre Pepin, the company's vice president of sales and marketing, components for his company's UAVs "are available online or wherever you have a hobby shop." The main reason that people buy UAVs, he points out, is that they are cheaper to buy and operate than aircraft, especially in Third World economies.

MicroPilot began to build UAVs for farmers and scientists but now builds them for all kinds of clients. See ***Figures 7-10*** on pages 27 and 31. "One shot some footage with a digital video camera that ended up in a one hour BBC presentation; another one wants to fly over the Galapagos Islands to map invasive species; one uses it to map land mines," says Pepin.

One limitation of these low-end UAVs is that they cannot fly when winds are over 30 miles per hour or very gusty, says Pepin. Furthermore, the FAA has banned most UAV flights over the continental United States because, unlike human pilots, UAVs cannot "sense and avoid" other aircraft. However, the University of North Dakota has bought a couple of MicroPilot's crop cameras and is working with the FAA to develop standards for UAVs.

UAVs as remote sensing platforms have given many research groups the opportunity to acquire data at sufficiently low cost to justify the use of remote sensing in the first place. Once airspace regulations have been adapted to accept them as regular aircraft, these platforms may therefore become the catalyst for many new users and uses of remote sensing.

have and use it to drive other geospatial software, such as Google Earth."

The latest version of SOCET GXP enables users to track moving objects they select on screen, as well as to push the video's telemetery data into a sensor model and use it to extract the coordinates of the moving object and monitor its speed and heading. See ***Figures 2-6***.

These data streams raise concerns about processing power, says Bower. "If you have a video at 30 frames per second, any advanced computation on those frames—even something as simple as sharpening and dynamic range adjustment—could incur a very big CPU processing cost, because you have to re-do the operation for every new frame."

UAVs can employ various methods to reduce the amount of bandwidth needed to transmit video streams by several orders of magnitude. First, their on-board computers can disseminate only the most pertinent data. Second, they can recognize targets and transmit their coordinates rather than large imagery files. Finally, when they do need to transmit large volumes of data, they can use advanced data compression to reduce bandwidth requirements.

SOURCES

1. "The Rise of the Pilotless Planes: Are Remote-controlled Drones—Used in Iraq and Increasingly in Pakistan and Afghanistan—the Future of Warfare?" *The Week,* April 9, 2009, www.theweek.com/article/index/95250/The_rise_of_the_pilotless_planes.
2. Andrea Shalal-Esa, "Firms Vie for Share of Growing Unmanned Plane Market," Reuters, Aug. 11, 2009, via www.washingtonpost.com.
3. J. Everaerts, "The Use of Unmanned Aerial Vehicles (UAVs) For Remote Sensing and Mapping," *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.* Vol. XXXVII. Part B1. Beijing 2008 www.isprs.org/congresses/beijing2008/proceedings/1_pdf/203.pdf.
4. James Risen and Mark Mazzetti, "C.I.A. Said to Use Outsiders to Put Bombs on Drones," *The New York Times,* Aug. 20, 2009.
5. *The U.S. Air Force Remotely Piloted Aircraft and Unmanned Aerial Vehicle Strategic Vision* (2005), www.uavforum.com/library/usaf_uav_strategic_vision.pdf.
6. Turner Brinton, "New Aerial Drones to Be Compatible with WGS Satellite Constellation," *Space News Business Report,* www.space.com, July 31, 2009.

BUILD the community
ACCELERATE innovation
ADVANCE the tradecraft

United States Geospatial Intelligence Foundation

geoint 2009 symposium

October 18 – 21, 2009 • San Antonio, Texas

Save the Date for GEOINT 2009!

GEOINT Returns to San Antonio for the Sixth Annual Symposium!

GEOINT 2009 promises to bring together an exciting line-up of speakers building on the dialogue from the past five years' highly acclaimed events. Attendees will have the unique opportunity to hear advice from leading experts, share best practices and uncover the latest developments from government, military and industry leaders through an exhibit hall of more than 100,000 square feet.

Registration & Housing Opens July 15!

CONFIRMED KEYNOTE SPEAKERS

The Honorable Dennis C. Blair
Director of National Intelligence

The Honorable James R. Clapper Jr.
Under Secretary of Defense for Intelligence, Office of the Secretary of Defense

Vice Adm. Robert B. Murrett, U.S. Navy
Director, National Geospatial-Intelligence Agency

Lt. Gen. David A. Deptula, U.S. Air Force
Deputy Chief of Staff for Intelligence, Surveillance and Reconnaissance

USGIF *Where Our National Security Begins...*

www.geoint2009.com

ADVERTORIAL

One Year Anniversary of GeoEye-1

On Sept. 6, 2009, GeoEye, a premier provider of satellite and aerial-based geospatial information and services, celebrated the one-year launch anniversary of GeoEye-1, the world's highest resolution and most accurate commercial Earth-imaging satellite.

Launched from Vandenberg Air Force Base, California, GeoEye-1 has imaged every continent in the world. Its best ground resolution is .41 meters (about 16 inches) in black and white mode and 1.64 meters in color. That means GeoEye-1 can 'see' an object the size of home plate on a baseball diamond, but more importantly, it can map the location of an object that size to within 3.5 meters (about 9 feet) of its true location on the Earth's surface. GeoEye was the first to achieve this unprecedented level of inherent mapping accuracy in a commercial imaging system.

Since its launch, the satellite has:

a. *Collected nearly 54 million square kilometers of imagery;*

b. *Taken more than 200,000 images;*

c. *Flown more than 236 million kilometers around the Earth;*

d. *Orbited the Earth exactly 5,340 times as of its one-year anniversary in space.*

"The past year has been an exciting and rewarding one for GeoEye," said Bill Schuster, GeoEye's Chief Operating Officer. "With the launch of GeoEye-1 last September, we put into service the world's most advanced commercial imagery satellite, which is delivering the highest resolution, most accurate color satellite imagery available today."

GeoEye-1 has chronicled several noteworthy events this year, including President Obama's inauguration ceremony in Washington, D.C. in January. In April, GeoEye-1 photographed a secret North Korean missile facility just moments before the launch of a long-range missile.

In celebration of this launch anniversary, GeoEye tasked the GeoEye-1 satellite to collect imagery of Madrid, Spain. The full high-resolution image was featured on GeoEye's corporate home page at www.geoeye.com, along with a full gallery of stunning images that range from the newsworthy, to natural features including islands and volcanoes, to manmade features including ancient sites and cities of the world and much more.

Today, GeoEye is recognized as one of the geospatial industry's imagery experts, delivering imagery products for a wide array of applications for defense, national and homeland security, air and marine transportation, oil and gas, mining, infrastructure, mapping and location-based services, insurance and risk management, agriculture and environmental monitoring.

Headquartered in Dulles, Virginia, GeoEye is a public company listed on the NASDAQ stock exchange under the symbol GEOY. GeoEye supports academic institutions and non-governmental organizations through the GeoEye Foundation (www.geoeyefoundation.org).

This satellite image of the Royal Palace of Madrid (Palacio Real de Madrid), Spain was taken from 423 miles in space by the GeoEye-1 satellite on Sept. 7, 2009. The image shows The Sabatini and Royal Gardens and the Teatro Real Opera house beyond the Oriente Square to the east. The Royal Palace of Madrid is the largest in Western Europe with 2,800 rooms. The GeoEye-1 satellite is owned and operated by Virginia-based GeoEye, Inc. and is the world's highest resolution commercial Earth imaging satellite.

CRADA

GOVERNMENT USES R & D PARTNERSHIPS TO SOLVE REAL CHALLENGES

MANY GOVERNMENT ORGANIZATIONS ARE TAPPING THE private sector for technology and expertise to meet their missions more effectively. Leveraging resources, strengths and specialized skills to meet the unique needs of individual agencies, public-private partnerships can bring together the best of both worlds when implemented well. A Cooperative Research and Development Agreement (CRADA) is a unique partnership providing innovative technology solutions to the public sector. This partnership leverages private sector resources and knowledge, while providing agency-specific guidance and insight into its unique needs and challenges at no financial cost to the government.

A mutually beneficial public-private partnership, the CRADA offers both parties the opportunity to share technical expertise, ideas and information in a protected environment. Originally authorized in 1986 as a means of expanding technology transfer between the private sector and federal laboratories, and deemed a major factor contributing to the economic strength of the United States, a CRADA agreement ultimately strives to advance science and technology that not only meets government objectives but also has viability in other potential commercial applications. The candid interactions that are nurtured through a CRADA bring public enterprises and private companies closer together for a mutual goal – delivering state-of-the-art technology solutions that solve real mission-critical problems.

As our country continues to face economic challenges, partnerships that leverage resources and stretch research budgets are increasingly critical to the government in meeting the needs of its citizens and in securing public confidence. Now more than ever, the government is expected to do more with less, and to get it right the first time. When establishing a CRADA, government works closely with the private sector to ensure that the custom developments and unique challenges of individual government agencies are built into the resulting products, more efficiently meeting the needs of the partner government agency while reducing costs and maximizing resources.

STEVE PANZER
Vice President, Government Division
ObjectFX
Columbia, Md.
www.objectfx.com

Solutions that solve agency-specific challenges

Agencies within the Intelligence Community, like all government agencies, face unique challenges that can be solved by leveraging private sector technology and expertise. Some of the key problems faced within the Intelligence Community include the constantly increasing need for skilled analysts, an ever-expanding amount of intelligence data to sift through, and the urgency to sift through these mounds of data to quickly locate actionable intelligence.

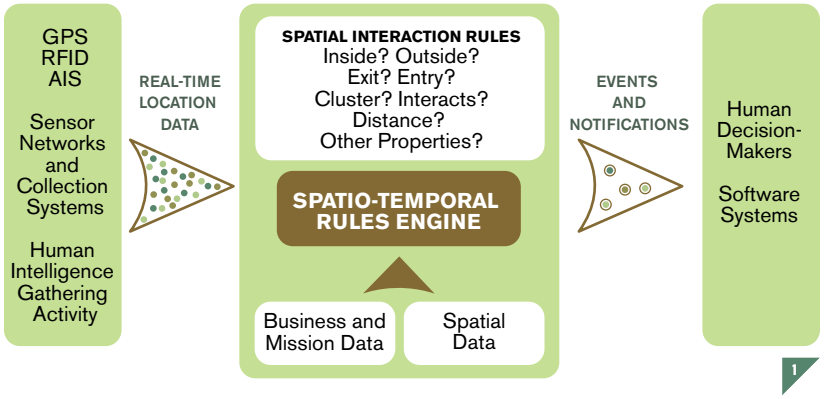
As senior analysts retire, there are fewer seasoned analysts to make sense of the deluge of information, so important data might be lost or overlooked, and critical trends are not identified. As junior analysts continually take the reins from senior analysts, it becomes even more crucial that procedures are captured and standardized, condensing manual intellectual labor so that more time can be spent identifying actionable intelligence.

Through a CRADA with geospatial solutions provider ObjectFX, the National Geospatial-Intelligence Agency (NGA) is moving quickly and efficiently to address these types of challenges by enhancing ObjectFX's offerings and by defining and fine-tuning the features required for its newest product, a spatiotemporal rules engine (see ***Figure 1***), designed with input through the CRADA specifically to address real-world Intelligence Community use cases and scenarios.

Working with NGA via a CRADA initially signed in 1999, ObjectFX has been providing its Java-based geospatial software platform, which enables the integration into enterprise applications of location-based services, like vehicle routing (see ***Figure 2***) and address geocoding, for organizations throughout civilian, intelligence and defense communities. In response to its customers' requests and needs, ObjectFX added support for geospatial data types, like raster/vector maps and high-resolution imagery specific to the intelligence community, as well as military standard 2525B symbology, to its suite of geospatial solutions.

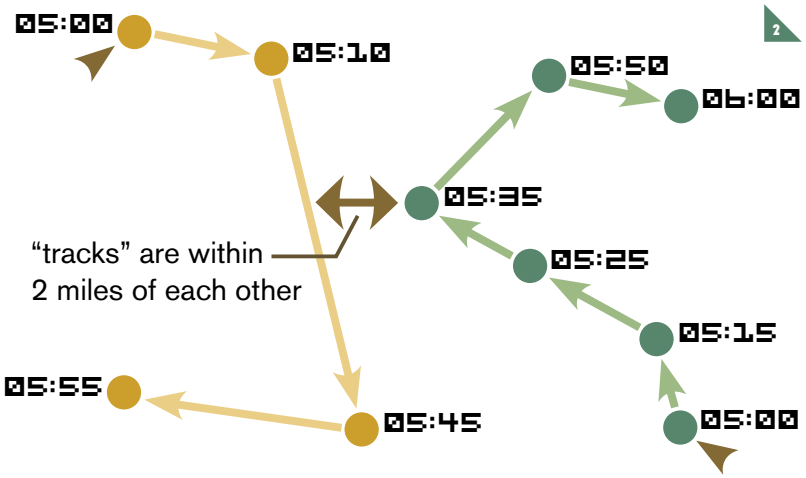
▼ **FIGURE 1**

A spatiotemporal rules engine filters a stream of real-time sensor-based data, identifying actionable intelligence.



▼ **FIGURE 2**

A spatiotemporal rules engine can track vehicle routing information, determining when two vehicles are within a given proximity of each other within a specified amount of time. Utilizing a "breadcrumb trail," two vehicles need not be in the same place at the same time to alert security officials.

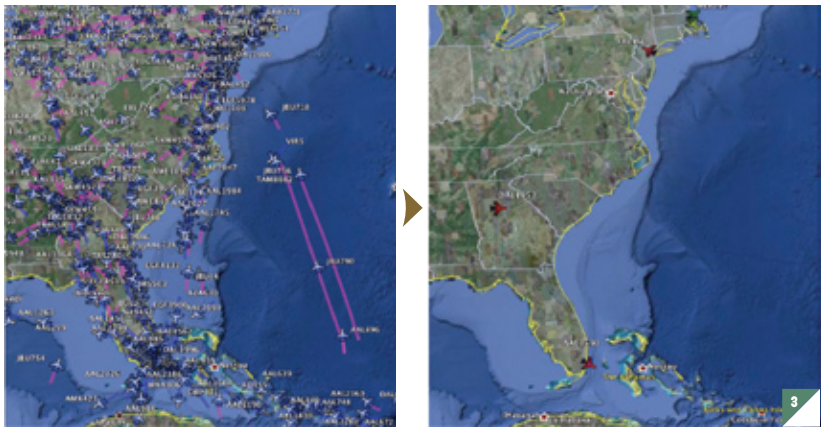


When the intelligence community expressed the need for a spatiotemporal rules capability about three years ago, the focus shifted to developing and enhancing the SpatialRules functionality, and applying it towards multi-intelligence use cases within advanced geospatial intelligence. The initial major deployment of SpatialRules went live with another intelligence community mission partner in April, 2009.

SpatialRules is a spatiotemporal rules engine that manages a flood of real-time sensor-based information, enabling analysts to make better use of their time by more quickly and efficiently identifying actionable intelligence – getting the right information to the right people at the right time. A spatiotemporal rules engine is a software component for analyzing spatial and temporal conditions against a set of rules, in this instance scanning specific areas of interest for suspicious activity based on proximity, density, and routing and tracking information (see ***Figure 3***). Before implementing this rules engine,

intelligence analysts spent a significant amount of time retrieving data, studying movement patterns on a geospatial display, and manually detecting events for further investigation. A spatiotemporal rules engine significantly reduces the manual labor by automating the monitoring process, enabling geospatial event processing in real-time. Increased accuracy and efficiency of monitoring provide more time for analysis of high-interest objects or events, exponentially increasing the probability that critical information will reach its destination in time to impact a critical decision.

Through this ongoing partnership, NGA and the rest of the intelligence community benefit from direct, hands-on access to leading commercial, off-the-shelf tools and technologies that can be modified or created to meet custom intelligence needs and requirements. Infinitely renewable, these collaborative, cooperative, and mutually beneficial partnerships utilize known government providers with forward-thinking and innovative technologies to solve government problems at minimal cost. By combining resources like facilities, equipment, expertise and personnel, the government can meet their ultimate goal of doing more with less – stretching research budgets while consuming fewer resources.



▲ **FIGURE 3**

This image of aircraft on the East Cost demonstrates the benefits of data reduction. Through customizable rule layers, a spatiotemporal rules engine enables users to sift through the deluge of real-time sensor-based information, locating the actionable intelligence. In this example, rule layers have been customized to pinpoint commercial aircraft that are too close together, those that have entered a "no-fly" zone, or any plane that is close to or has entered a severe weather zone.

> **A SPATIOTEMPORAL RULES ENGINE SIGNIFICANTLY REDUCES THE MANUAL LABOR BY AUTOMATING THE MONITORING PROCESS, ENABLING GEOSPATIAL EVENT PROCESSING IN REAL-TIME.**

A win-win situation for all

The CRADA provides equal opportunity to all private sector companies, enabling any qualified company with common research and development goals to enter into a CRADA agreement with a government agency. As the relationship is mutually beneficial, both the government agency and the private company meet specific organizational goals through the agreement. There is no monetary exchange in a CRADA, satisfying a goal for the government agency, as there is no direct budget impact. Although the private company does not receive financial compensation, the agreement provides distinct advantages for the private company.

The CRADA provides companies with direct insight into specific needs of government agencies (within defined security clearance boundaries, of course). Companies are also able to access agency data, data standards and processes within the designated facility, running it through their technology to enable a better understanding of specific use cases and scenarios.

Companies gain an added benefit of acquiring more depth of knowledge regarding the government agencies they serve, expanding that company's expertise and value with other government agencies moving forward. Proprietary rights and ideas of the private company are also protected. In signing this agreement, all parties agree to keep research results confidential until published or commercialized, and the private sector research partner typically takes title to any new inventions.

In order to meet the needs of government agencies and their customer bases most efficiently, public-private partnerships are gaining momentum. The government's demands for more advanced technological innovations while balancing smaller budgets can be met through the CRADA, truly a mutually beneficial relationship between a federal agency and a private company. While our country continues to face economic hardship, partnering with the private sector not only provides more quickly commercialized technology that directly addresses the needs of individual government agencies, but by optimizing resources, it stretches the research and development budget, enabling taxpayer dollars to travel further in support of our nation's missions. «

EDITOR'S NOTE

More information on the NGA CRADA program is available on the web at www.nga.mil/crada. The NGA CRADA team is available to field questions on the program and can be reached via email at crada@nga.mil.

Maximize the Value of Your Imagery

Quickly get imagery to people who need it with the ArcGIS® Server Image extension.

"When we tested ArcGIS Server Image extension, we found designers, technicians, and digitizers were all very pleased with the processing time. It was twice as fast, in some cases even faster, than previous systems."

Cindi Salas
GIS Manager
CenterPoint Energy

The ArcGIS® Server Image extension helps organizations manage large catalogs of rasters and imagery to make imagery available to more people in less time. Dynamic mosaicking and on-the-fly image processing allow users to quickly serve multiple imagery products from one set of source imagery, reducing data redundancy and storage requirements.

For more information, visit **www.esri.com/image** or call 1-888-373-1353.

For ESRI locations worldwide, visit **www.esri.com/distributors**.

ESRI®

Copyright © 2008 ESRI. All rights reserved. The ESRI globe logo, ESRI, ArcGIS, ESRI—*The GIS Company*, www.esri.com, and ©esri.com are trademarks, registered trademarks, or service marks of ESRI in the United States, the European Community, or certain other jurisdictions. Other companies and products mentioned herein may be trademarks or registered trademarks of their respective trademark owners.

SOCET GXP® SOFTWARE.
EXPERIENCE THE POWER OF EXTREME ANALYSIS.™

Experience the power of real-time image analysis, automated geospatial production, mapping, and 3-D visualization — all in a single application. SOCET GXP® enables interoperability and collaboration among users and decision-makers at all levels, and its intuitive, customizable interface provides direct access to shared databases and extended capabilities. Image and geospatial analysis — together for the first time in one powerful tool. This is just one of the ways BAE Systems delivers real advantage.

BAE SYSTEMS

www.baesystems.com/gxp

REAL PERFORMANCE. REAL ADVANTAGE.