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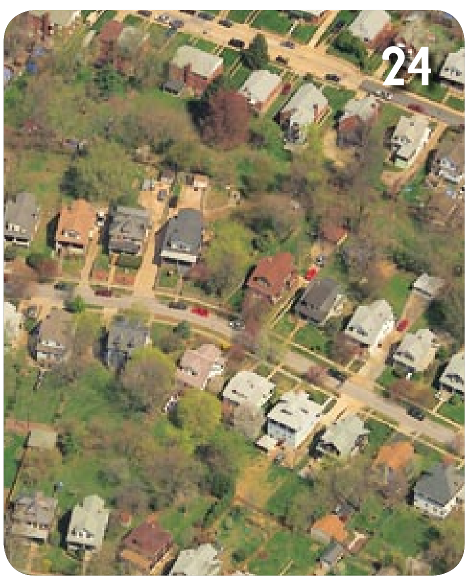

features

Baltimore, Md. is an ideal city to be featured in this Fall Imaging Notes issue, which provides primary focus on security and defense. Baltimore is featured prominently in the article about new developments in municipal security on page 24, and as a major port city, it's also relevant for the transportation security report beginning on page 10.

As Maryland's biggest city and one of the nation's busiest ports, Baltimore's position at the end of the Patapsco River that feeds into Chesapeake Bay gives the city easy access to the Atlantic Ocean, so the city became an important port and shipbuilding center. It was home to a large number of U.S. Navy vessels, as well as the famously swift Baltimore clipper ships that destroyed or captured many of the British merchant ships during the War of 1812. Baltimore played a crucial role in the War of 1812, when soldiers, stationed at Fort McHenry, successfully held off a British attack on Baltimore. That victory for Baltimore was commemorated in a poem by Francis Scott Key and is now our national anthem.

When the war ended in early 1815, Baltimore's overseas trade was principally with the Caribbean Islands and South America, regions undergoing economic and social changes. At the same time, the American frontier was pushing even farther west, threatening to leave Baltimore behind in its economic wake. The State of Maryland concentrated its efforts on completing the Chesapeake & Ohio Canal, designed to link the Potomac and Ohio River valleys, but the City of Baltimore supported an overland link in the form of the Baltimore & Ohio Railroad. Although the two competed for routes and freight, to the eventual ruin of the canal and the financial embarrassment of the state, Baltimore's railroad reached Cumberland in 1842 and, by 1874, stretched to Chicago.

Much of the city was destroyed in a 1904 fire, but Baltimore came back and continues to evolve while holding on to its maritime heritage. Since 1600, Baltimore waterways have been a passage for ships carrying commercial cargo and new citizens. It lies farther west than any other major Atlantic port, a point that endeared its harbors to shippers. More than 30 million tons of cargo pass through the port of Baltimore every year. (Information from www.baltimore.org.)

This IKONOS 1-meter image from Space Imaging was collected on November 4, 2003.

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The Landsat Saga: Reflecting and Projecting

Every so often a reporter calls to ask for my views on the Landsat program or its follow-on, the Landsat Data Continuity Mission (LDCM). First, I usually issue a long sigh — not the journalist's fault — he or she is just trying to do a credible job of gathering news and viewpoints. I sigh from the apparent inevitability of policy stumbles in providing Landsat data to the remote sensing community.

The status of the Landsat program has been precarious at least since the late 1970s when the Carter administration decided to turn Landsat operations over to the private sector. NASA officials, who wanted relief from the responsibility for operating the Landsat system, also urged a transfer. Market optimists argued that the private sector would be able to develop sufficient data sales to support continued Landsat operations.

Even then, most analysts realized that such a move was ill advised; for them, a viable Landsat data market was more wishful thinking than reality. By the late 1970s, sales of Landsat data were extremely small, and even the more powerful Landsats 4 and 5 (launched in 1982 and 1984 respectively) were unlikely to generate an adequate market. Most of the government-funded studies supported this dismal conclusion.

The Reagan White House was even more supportive of a transfer. That administration wanted to move as many government programs as possible into private hands. Congress followed along by passing the 1984 Land Remote-Sensing Commercialization Act, which transferred Landsat operations to NOAA and directed that agency to select a commercial operator for Landsats 4 and 5. Over the next few years, EOSAT, the private operator NOAA selected, was unsuccessful in building sufficient data sales, and EOSAT's Landsat 6 failed to reach orbit, dooming the commercial program.

This experiment in privatization lasted only until 1992 when Congress reacted to the impending lack of Landsat data by passing the Land Remote Sensing Policy Act (Public Law 102-555). The law moved the development and operation of Landsat 7 back under government control, setting the stage for a very successful Landsat 7 mission. Under NASA development, and with operations by the U.S. Geological Survey (USGS), the spacecraft has collected thousands of high quality images of most of the land area of planet Earth, imagery that has proved highly useful for hundreds of scientific and governmental applications around the world, wherever wide coverage and high radiometric fidelity are required.

Fortunately, even the failure of the sensor's scan line corrector in May 2003 has not shut down Landsat 7 operations. NASA and USGS have devised a means to patch in data from the corrupted areas of the scene with data acquired either before or soon after. While this fix does not substitute entirely for the "real thing," it vastly improves the utility of the data. Each scene comes with a key showing precisely where data from a different scene have been added.

The 1992 law made private sector ownership and operation of remote sensing systems more commercially attractive. Now three U.S. companies operate highly capable, high resolution commercial systems. The three competitors will soon reduce to two when OrbImage completes its buyout of Space Imaging. The combined company will then compete for market share only with DigitalGlobe. The U.S. high resolution industry, if not yet robust, is now growing in size and global reach. With U.S. policy and companies in the lead, the rest of the world is moving into orbit with a wide variety of spacecraft.

Meanwhile, U.S. policy towards Landsat data continuity falters. Data continuity is required by Public Law 102-555 because it is important for the many applications of Landsat data to federal and state agency needs. Nevertheless, it is continually at risk from infighting among the various federal agencies that use the data. Basically, they all want the data, but only if another agency pays for the system. Because the Landsat series serves a varied set of users in both the scientific and applied communities, it has never had a strong agency champion.

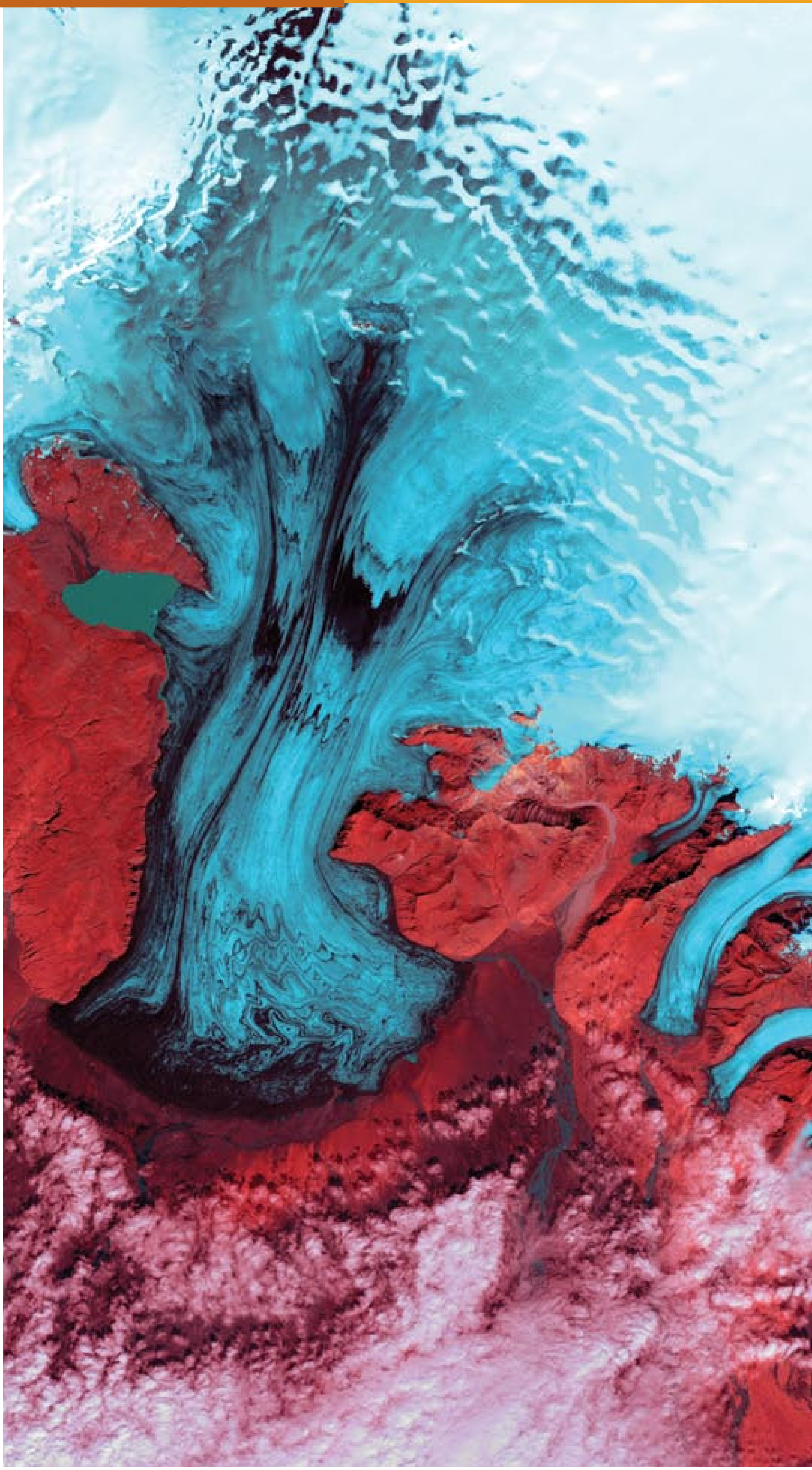
Even though its scientists make extensive use of Landsat data, NASA does not want to continue building and launching Landsat satellites. It would like to move on to more challenging engineering and scientific projects. However, without major changes in their budgets and focus, neither NOAA nor USGS can support such a project. As agencies within much larger departments, they also have a difficult time justifying a large budget increase. The Department of Defense (DOD), which yearly uses thousands of Landsat scenes, is not willing to pay for the system either.

After many false starts and delays, there is now a plan that would place a Landsat-type Operational Land Imager (OLI) on the NPOESS satellites. These are the new, improved meteorological satellites developed by NOAA, NASA, and DOD. However, the first of the NPOESS birds is now scheduled for launch only in 2010 (http://ldcm.usgs.gov). Thus there will likely be a significant Landsat data gap, as the only Landsat satellites now operating are the damaged Landsat 7 and, amazingly, Landsat 5, which was launched in 1984.

The NPOESS satellites will fly in a different orbit from Landsat 7, yielding a smaller scene size (177 km, versus 185 km) and different scene center line. The OLI, which is not yet designed, would maintain the same 30-meter multispectral and 15-meter panchromatic resolutions and contain three additional spectral bands compared to Landsat (one blue and two short wavelength infrared). Unlike Landsat 7, it would not carry a thermal band. It is not clear that data users will find such changes immediately workable, since even relatively small changes in the data characteristics may require significant changes in their applications algorithms. Users of the thermal band are simply out of luck in the OLI era.

Still to be worked out is the funding for the sensor, additional ground systems, and operations costs, which could further delay the system. In other words, do not expect to see the impending data gap filled any time soon.

Ray A. Williamson **is research professor of space policy and international affairs in the Space Policy Institute of The George Washington University, Washington, D.C.**



Valley glaciers appear as fingers of blue ice reaching out from the Vatnajökull Glacier in Iceland's Skaftafell National Park. The park lies on the southern edge of Vatnajökull, Europe's largest ice cap. Landsat 7 image captured August 4, 1999, courtesy of USGS and NASA.

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Improving Surface Transportation Security

THE ROLE OF GEOSPATIAL TECHNOLOGIES IN INTERMODAL FREIGHT AND HAZARDOUS MATERIALS TRANSPORT

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The effects of the frightening terrorist attacks on the United States on Sept. 11, 2001, reached far and deep into American society and beyond. Since then, virtually every organization throughout the world has confronted the question of how it can improve security and resilience to terrorist attack. The recent social disruption and extreme damage from hurricanes Katrina and Rita raise related questions for planning for and response to natural disasters.

Transportation security is, of course, of highest concern not only because breaches in airline security allowed the Sept. 11 terrorists to use civil aircraft as high-energy weapons, but also because vulnerabilities throughout the surface transportation system make many elements of the transportation infrastructure potential targets of terrorist activity. Intermodal freight transport and the surface transport of hazardous materials are of particular concern to transportation officials.

The safety and security of surface transportation (including subway transit) have gained additional salience since the coordinated July 7 bombing of three subway trains and one bus in London. U.S. transportation officials and policymakers are specifically addressing the important question of what needs to be done to strengthen security for the country's surface transportation systems, systems that are particularly vulnerable to attack.

Remote sensing, geographic information systems (GIS), position, navigation, and timing (PNT) and other geospatial technologies provide powerful tools for dealing with these important security concerns. To aid in focusing research and development efforts, the R&D community needs to hear from state and local officials about their specific needs and concerns. This article summarizes the efforts of the Consortium for Safety, Hazards, and Disaster Assessment of the National Consortia for Remote Sensing in Transportation (NCRST-H) to develop a workable agenda for research, development, testing, and implementation of geospatial tools to improve transportation security. Although its recommendations are targeted specifically for implementation in the United States, most of them can be applied throughout the world.

THE TRANSPORTATION SECURITY CHALLENGE

Protecting America's many different transportation components from attack or from being used to attack other elements of U.S. critical infrastructure is a daunting task. Included are: 4 million miles of roads, 500,000 bridges, 150,000 rail track miles, 5,500 public use airports, 25,000 miles of waterways, 1.6 million pipeline miles, and 5 million containers traveling through U.S. ports per year.

Intermodal transport poses a special challenge to transportation security because freight containers generally travel long distances and may change transportation mode several times in passing from supplier to customer, allowing intervention from terrorist elements. Some five million containerized freight shipments move through America's ports each year, creating a significant challenge to security personnel at all levels. After arriving on U.S. shores from myriad other countries, the containers are loaded onto trucks and rail cars and shipped throughout the U.S.

Hazardous materials pose their own challenges. Some of the more common and familiar transport items that move through thousands of urban centers daily pose extraordinary risks to security, including:

a. Chlorine (45,000 rail shipments of chlorine annually)
b. Anhydrous Ammonia
c. Gasoline (50,000 truck shipments of gasoline daily)
d. Propane Gas
e. Explosives (125,000 truck shipments of explosives annually)
f. Radioactive Materials

Geospatial experts can take information developed by experts in terrorist methods and use geospatial technologies to explore a variety of possible terrorist scenarios. Modern analytic and display software allows rapid processing of possible geographic approaches in three dimensions and helps analysts discover infrastructure vulnerabilities that may not be immediately apparent to the eye, even to individuals familiar with an area.

Remotely sensed imagery, especially that from high resolution commercial satellites and digital sensors aboard aircraft, can assist in surveying and monitoring conditions around critical infrastructure. In combination with other geospatial tools, imagery can then be used to assist in mitigating the effects of any possible future terrorist incident. Recent research by Imagecat, Inc. has shown that for hurricanes and earthquake damage, high resolution imagery delivered immediately after a natural disaster may be crucial in assessing damage and mapping areas most in need of ameliorative response. One need only have watched any news broadcast to see the utility of aerial and satellite imagery for assessing damage following the devastating Hurricane Katrina in the U.S. Gulf Coast region. Similar assessment tools can be used in case of a successful attack to guide response teams in the field. Indeed, the experience of the country's

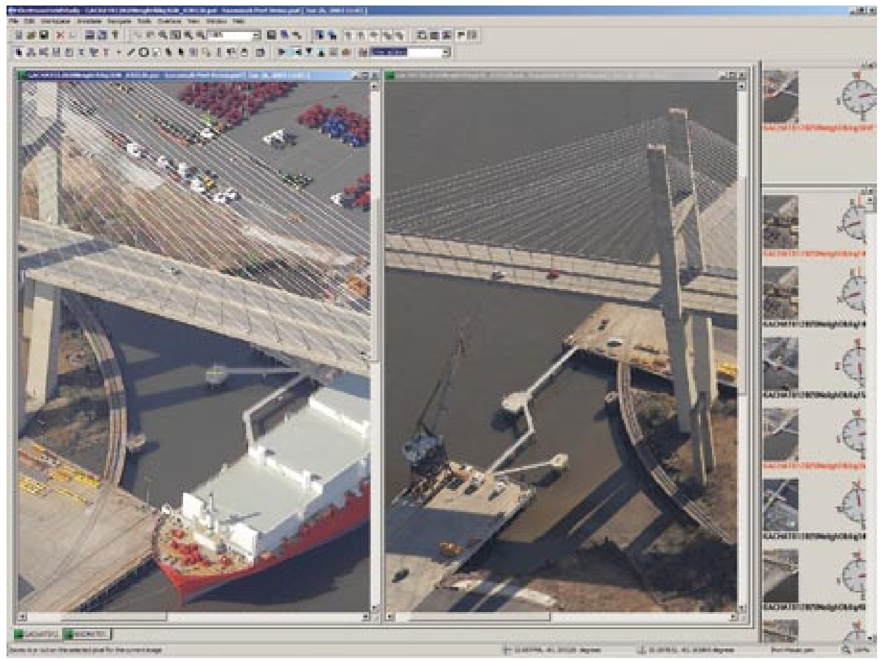

Figure 1 *Infrastructure elements in the Port of Savannah, Ga. Oblique digital imagery with embedded GPS positions make possible a new level of remote sensing analysis, including the capability to see under bridges. The images are captured from opposite sides of the bridge and displayed at different scales. The red crosses in each image mark the same point along the rail section. Image courtesy of Pictometry, Inc.*

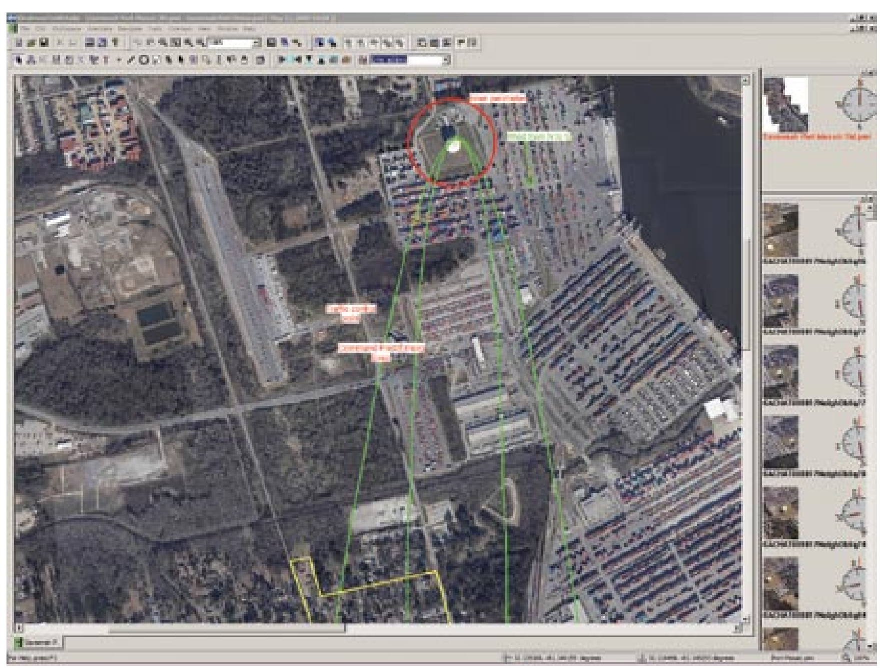

Figure 2 *Attack scenario of the Port of Savannah, Ga. with digital oblique imagery and embedded GPS positions. This is a model of a chemical plume released by an attack, incorporating wind patterns.*

uncoordinated response to this damaging natural event should prove extremely helpful in designing and implementing improved planning and response methods.

IMPROVING INTERMODAL AND HAZARDOUS MATERIALS TRANSPORT SECURITY

Intermodal and hazardous materials transport are closely interlinked, and many of the security issues faced in each are similar or overlapping. For example, hazardous materials often travel by the same or similar intermodal routes required for the transport of non-hazardous materials. Nevertheless, the security issues for each also differ. For intermodal transport in general, security concerns tend to focus on whether or not terrorists are bringing destructive chemical, biological, or nuclear materials into the country covertly. In the case of commonly transported hazardous materials, security interests tend to focus on keeping close track of the materials along their routes.

Box H

RESEARCH AND IMPLEMENTATION AGENDA FOR INTERMODAL FREIGHT TRANSPORT

CURRENT PRACTICES	NEAR-TERM	MID-TERM
Positive train control systems	Identify vulnerable nodes using image data	Develop visualization tools to create, analyze and test a variety of threat scenarios
Digital data link communications	Categorize high-risk cargo and transportation segments	Begin 3-D modeling, characterize highly vulnerable lifelines and infrastructures
Inertial sensors	Establish high priority management areas	Acquire and ingest advanced sensor data into routine image-based applications
Nationwide differential GPS	Integrate raster/vector data with other intelligence and land-based information	Intensify sensor R&D for bio-chemical agents
Automatic equipment ID	Ingest data in GIS architecture	Test new products and tools in collaboration with early adopters
Electronically controlled pneumatic train brakes	Develop relational databases	
Intelligent grade crossings	Develop archive of datasets (spatial and non-spatial)	
	Identify early adopters of new technology and tools among transportation community	
	Demonstrate and test products and tools in collaboration with early adopters	

INTERMODAL TRANSPORT

The logistical complexities of intermodal or multimodal transport make this sprawling component of the transportation industry extremely difficult to secure. It will be imperative to integrate information management tools, such as databases and statistical analyses, with geospatial technologies to increase the overall effectiveness of protection strategies. Needed is a suite of tools, including: advanced cargo shipping information, automated manifest interface, advanced profiling, and vulnerability and risk assessment tools. Systems for automated identification and communication of high-risk cargo are also needed.

Multispectral and SAR imagery can be used to monitor and analyze the areas around ports, rail facilities, and trucking terminals to assure that they remain as secure as possible from attack. Active multispectral sensors capable of monitoring the local atmosphere around these facilities can test for chemical and biological agents. Digital video from near-ground platforms (e.g., towers, tethered balloons) and aircraft can be used in real-time to assure that an area remains secure, particularly while loading and unloading container ships. Information from these digital video images can be merged with other information to form extremely powerful analytic tools both for real-time and historical analysis.

SECURING HAZARDOUS MATERIALS TRANSPORT

The transport of hazardous materials requires special attention because the materials themselves pose particular health and safety hazards, regardless of terrorist concerns. The sheer volume of hazardous materials transported every day through towns and cities increases the difficulty of tracking them. Geospatial tools, combined with advanced communications technologies, can ease this burden and provide better quality information for security officials.

Among other things, geospatial tools such as mobile mapping and temporal change detection allow users to speed up the production and even automate many tasks now carried out by hand. If properly developed and tested, these tools can provide precise position information and more details about the environs of the transported material. For example, if a shipment is attacked or communication is lost, highly detailed, image-based maps of the route can help authorities answer such questions as: What is the physical environment in the area of last communication? What is the quickest route to reach the area?

INTEGRATING GEOSPATIAL TECHNOLOGIES INTO TRANSPORTATION SECURITY SYSTEMS

Geospatial technologies can assist in improving the security of roads and highways, rail transportation, and ports for both intermodal and hazardous materials transport.

ROADS AND HIGHWAYS

Geospatial technologies are particularly powerful in analyzing vulnerabilities in highway infrastructure elements and reducing their exposure to attack, or to congestion in rapid area evacuations. For example, they offer a vast improvement in speed, accuracy, and repeatability over manual methods such as "windshield surveys" in which two individuals drive the route taking notes on the factors that could affect route security.

Combining such manual methods with modeling software would enable the development of a hierarchical set of decision support tools capable of assisting transportation managers to select routes and risk-reduction strategies for route segments that carry unavoidably high risk. These "virtual surveys" can be updated quickly and cost effectively using remote sensing methods and mobile mapping.

If geospatial information about critical transportation assets is kept up-to-date and available in searchable databases, these same technologies can assist first responders in case of an attack by providing detailed routing and terrain information. Such information will improve the speed and quality of the response while at the same time improving safety and reducing casualties.

RAIL

For rail security, one of the primary needs is to develop "intelligent railroad systems" that employ digital data communication, data, and on-board sensors for improving safety and security of the trains and their cargos.

Ultimately, intelligent railroad systems allow operators to respond to unexpected events virtually anywhere in their systems. Taken together these benefits provide broad incentives for rail operators to institute such improvements as the use of digital data link communications, positive train control, nationwide differential GPS, automatic equipment identification, electronically controlled pneumatic train brakes, and intelligent grade crossings.

Positive train control systems are digitally linked communication systems that provide safety benefits by preventing collisions, preventing over-speed accidents, and protecting roadway workers. They can enhance rail security by monitoring location and speed of all trains, and by monitoring the status of all rail switches. Such systems can make excellent use of the National Digital GPS (NDGPS) system that is currently operational throughout most of the United States.

These technologies, which provide continuous, real-time information, enhance security through prevention, detection, and notification of rail accidents and other incidents. They also assist in the recovery from incidents. Because the security of information provided by intelligent railroad systems is itself of great concern, systems to provide information security must be designed into them from the beginning.

Remotely sensed data provide an excellent, unbiased source of information for determining rail transportation vulnerabilities. When combined with intelligent railroad systems in a GIS framework, such data provide an additional margin of safety for the transport of hazardous materials.

PORTS

Ports constitute a significant element in the nation's transportation infrastructure, for they serve as primary transportation nodes for transferring cargo to and from ships to rail and highway transportation. Port security and the ability to respond quickly and efficiently to attacks can be increased substantially through the use of geospatial technologies.

Aerial and satellite imagery are particularly valuable for viewing and analyzing vulnerabilities within and around ports. A variety of geospatial tools is available for creating these. Pictometry, Inc., for example, employs a unique aerial system of oblique digital imagery acquired from many different angles. This technique enables the firm to explore a variety of scenarios to identify and test potential vulnerabilities of transportation routes into and out of the port ***(Figure 1, page 11)***. Note that in many situations, oblique imagery allows the camera to view under bridges and other structures to illuminate details that would be missed in most overhead imagery.

The system is also capable of undertaking threat and response analysis of potential attacks ***(Figure 2, page 11)***, helping port managers to identify the most important infrastructure on which to spend limited security budgets. Further, this tool, combined with other geospatial tools and risk models, can be used to support real-time decision making in case of attack. Figure 2 illustrates the ability of the system to allow modeling of a chemical plume released by an attack, using models of prevailing wind patterns. Note that in this case, the port's command center and main entrance lie in the path of the chemical plume. In the case of an actual attack, imagery acquired in advance can be retrieved and merged with real-time local environmental data in a model to estimate the spread of potential chemical plumes across an area. Such information can reduce the loss of lives of responders and those directly affected by the attack, and aid in rapid recovery.

MEETING THE NEEDS OF THE SECURITY MISSION

State and local agencies and officials are on the front line in the effort to meet terrorist threats. The following issues need to be addressed in the quest to develop adequate local transportation security:

ACCESS TO IMAGERY AND DATA FUSION

Remotely sensed data serve as decision-making tools for all levels of officials. There need to be clear policies for access to various types of geospatial information across and within political and geographical jurisdictional boundaries. First responders need access to critical information about pre-attack conditions of transportation links and the related infrastructure in order to establish an accurate baseline from which to work in providing succor to the injured and in clearing routes in and out of the affected areas. Such data would allow first responders to find street intersections and building foundations even when the surrounding areas are badly damaged or covered with debris as they were in the aftermath of the Sept. 11, 2001 attack.

Improvements in transportation security will require the fusion of many different kinds of data. Geographic information systems (GISs) generally serve as the integrative foundation and platform for fusing different forms of geospatial data with other forms of data, such as still and video imagery, street addresses, and structural types.

Box 1

RESEARCH AND IMPLEMENTATION AGENDA FOR HAZARDOUS MATERIALS TRANSPORT

CURRENT PRACTICES	NEAR-TERM	MID-TERM
Window surveys along routes	Identify vulnerable road segments using image data	Develop visualization tools to create, analyze and test a variety of threat scenarios
QUALCOM	Identify geographic areas at risk	Begin 3-D modeling, characterize highly vulnerable lifelines and infrastructures
TRANSCOM	Establish high priority incident management areas	Acquire and ingest advanced sensor data into routine, image-based applications
3-year database of visual observations	Integrate raster/vector data with other geospatial data	Intensify sensor R&D for bio-chemical agents
Intelligent railroad systems	Ingest data in GIS architecture	Test new products and tools in collaboration with early adopters
	Develop relational databases	
	Develop archive of datasets (spatial and non-spatial)	
	Identify early adopters of new technology and tools among transportation community	
	Demonstrate and test products and tools in collaboration with early adopters	

DATA INTEROPERABILITY, FORMATTING, AND ACCESS PROTOCOLS FOR MULTI-AGENCY USE

To reach the greatest effectiveness across institutional boundaries, data need to have sufficient commonality to allow sharing among different software platforms. At a minimum, geospatial data should conform to the standards of the Federal Geographic Data Committee (FGDC). Geospatial data and software should have additional characteristics in order to make them broadly useable, including multi-machine compatibility (desktop, laptop, handheld), commonality (of format, metadata, georeferencing) and connectivity.

EMPLOYING THE FULL RANGE OF REMOTE SENSING TECHNOLOGY AND DATA PRODUCTS

Many security needs can be met by existing technologies and by data products that have been developed for other purposes. Remote sensing methodologies exist to anticipate, plan for, and mitigate the effects of natural disasters. These methods include many that involve transportation in and out of the affected area.

SOURCES OF REMOTELY SENSED DATA

For U.S. transportation needs, numerous sources of remotely sensed data exist from both aircraft and space sensors. The choice of data source to use for transportation purposes depends on a variety of factors, including cost, ease of use, spectral characteristics, spatial coverage, and temporal characteristics. Potential aerial platforms range from single and twin engine fixed wing (propeller and jet), to helicopters and unpiloted air vehicles (UAVs) and even tethered balloons.

UAVs, although they are still very much under development, offer especially interesting possibilities for transportation security applications. The use of these systems in Afghanistan and Iraq to assist in peacekeeping, and in the U.S. Gulf Coast region following Hurricane Katrina will provide lessons for future applications of such systems. Further, the international community, especially Europe, is investing heavily in UAV R&D.

AWARENESS, EDUCATION, AND TRAINING

Outreach, education, and training have important roles in the effort to develop state, regional, and local capacities to secure and protect transportation infrastructure. One of the major barriers lies in the lack of understanding among responsible officials of how geospatial tools and data can assist transportation security. Agency officials need to understand that remotely sensed images are multilayered information sources that can dramatically change the way in which officials can carry out the mandates of their agencies. Training for using geospatial information also needs to be extended to first responder teams in order to improve their efficiency in understanding and using image data.

CRAFTING A RESEARCH AND IMPLEMENTATION AGENDA

Developing a clearly articulated implementation agenda is an important first step in the process of improving the nation's transportation security. Geospatial systems can enable the crafting and implementation of a new vision for homeland security, but the R&D community must continue to think and act creatively in order to make such a vision possible. NCRST-H created proposed research and implementation agendas for intermodal freight and for hazardous materials transport for consideration by policy makers and the research community ***(see Boxes H and I)***.

CONCLUSIONS

Remote sensing and other geospatial technologies provide many useful tools for improving and expanding U.S. transportation security. The introduction of such tools or their expanded use will also assist overall transportation safety. Nevertheless, geospatial technologies cannot provide the total solution. They must be integrated with other information and incorporated within appropriate institutional structures.

The research community needs to focus its efforts and funding on providing detailed geospatial information in useable forms that respond to the users' specific needs. Therefore, researchers need to collaborate with the local communities that will need geospatial tools to help them identify transportation vulnerabilities and imminent threats and to respond quickly and efficiently in case of attack. First responders are critical to preliminary planning, and in case of attack, to minimizing loss of life and damage to transportation infrastructure.

When integrated with other geospatial data, remote sensing provides an important tool in preparing the nation to meet the terrorist challenge. It is especially useful for developing the necessary background maps and analyzing various attack scenarios to assist in preparing for attacks on vulnerable facilities, and for increasing the possibility that attacks can be deterred.

This article is adapted from Ray A. Williamson and Amelia Budge, "Preparing for the Unknown: Geospatial Technologies for Improving Security in Intermodal Freight and Hazardous Materials Transport," National Consortium for Remote Sensing in Transportation-Hazards, Safety and Disaster Assessment, 2004. Many thanks to all those who contributed to this report.

Available at www.trans-dash.org/ and www.gwu.edu/~spi (reports). NCRST-H was funded by the Department of Transportation, Research and Special Programs Administration.

Security Risks of Public Access to Geospatial Data

SHOULD YOUR COMPANY HAVE A GEOSPATIAL DATA SECURITY PROGRAM?

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You are the CEO of a large geospatial company driving to work one morning, two days after an attempted terrorist attack on a large nuclear power plant 50 miles west of a major metropolitan city in the U.S.

You hear on the radio that the government believes other attacks on nuclear power plants are imminent. You also hear that police have found "satellite pictures" of the plant and the surrounding area in a suspect's house, as well as detailed "maps" of a nearby neighborhood that include routes to access the plant overlaid with personal data on the individuals living nearby. Related items were also found, including a number of computers and a GPS device.

Immediately, you call the office and learn that two government officials are already waiting for you. The company has also received a number of calls from the media, including one from a reporter who wants to know what you think about Senator Jones' recent statement on CNN that this information is another example of how we give terrorists too much access to information that is critical to our national security. The Senator is calling for immediate action, including Congressional hearings.

Upon arriving at the office, you learn that your company recently sold an image of the plant and surrounding area to an individual in New York City. Unfortunately, that customer gave a false address and the credit card he used turns out to have been stolen. You are also told that your help-desk received a call two months ago from someone who was looking for a way to search your archive for information "on all nuclear power plants in the United States and England close to major cities." The person who took the call also seems to remember the customer placing an order for an image of the subway and train system of a city in the United States but he can't remember which city. Or maybe it was another customer; he can't be sure. In any event, although he admits he found the call a little strange, he did nothing because he did not know whom to tell within the company.

You walk into your office and greet the two government officials, one of whom immediately hands you a subpoena requesting all geospatial products related to nuclear power plants your company has sold in the past two years.

GOVERNMENT OFFICIALS HAVE EXPRESSED POTENTIAL NATIONAL SECURITY CONCERNS ABOUT GOOGLE EARTH, AND THE MEDIA ARE ALREADY REPORTING ON ITS POTENTIAL RISK TO U.S. SOLDIERS IN IRAQ.

The scenario described above has not yet unfolded. However, given the abundance of satellite imagery, maps and related Web-based applications on the Internet, something similar is likely to occur in the near future. In fact, government officials have expressed potential national security concerns about Google Earth, and the media are already reporting on its potential risk to U.S. soldiers in Iraq. See ***Figures 1*** and ***2***. Such reports are likely to increase as the number of geospatial applications increases.

One significant step a geospatial company can take to prepare for this scenario, and others like it, is developing a comprehensive written security program with respect to geospatial data that can be considered sensitive. Such programs are not new; similar programs already are becoming the cornerstone of other industries that collect, process or use sensitive personal data, due in large part to federal legislation. For example, financial institutions are required to develop a written program under the Gramm-Leach-Bliley Act, so as to protect customers' bank account numbers and other sensitive information.

Many industry leaders expect that Congress soon will pass legislation requiring all companies with access to personal data — social security numbers, credit card information, etc. — to develop such programs. Similarly, laws such as the Patriot Act require that companies in designated industries develop programs to acquire and retain data on certain customers and transactions to assist law enforcement and intelligence agencies.

Geospatial data are not yet directly subject to any of these laws and regulations. However, geospatial data can be sensitive, particularly with regard to national security. As a result, government efforts to regulate geospatial data are likely to increase. By developing and implementing a comprehensive security program relating to its sensitive geospatial data, a company will be better prepared to manage government relations. Industry-wide adoption of such a program could preclude more onerous government regulation, such as shutter control, the Kyl-Bingaman Amendment (restricting the collection or dissemination of imagery of Israel), or allowing individuals, companies and governments to elect not to have geospatial data pertaining to them collected or distributed. In addition, such a program could limit a company's exposure in civil litigation matters.

A comprehensive geospatial security policy will depend upon a number of factors, including the size of the company, the type and nature of the data collected, and how the data are used and sold to customers. However, based upon programs in other industries, there are certain elements that every program should address.

THESE INCLUDE:

Identification of what constitutes sensitive geospatial data: Identifying which geospatial data are sensitive is surely subjective. For many companies, most geospatial data will not be sensitive. Data that relate to U.S. military forces, critical U.S. infrastructure or potential targets for terrorists, such as the nuclear power plant described above, might be considered sensitive. However, if there are readily available alternative sources for the data, a company may decide that the data are not sensitive. The nature of the data sets is also important. Whereas a simple image of critical infrastructure may not be deemed sensitive, a geocoded image of the same facility might be. The definition of sensitive data should be reviewed periodically, as what constitutes sensitive data will change as threats to security change. Also, geospatial data of a particular location can become less sensitive over time.

Introduction of procedures to mitigate risks: Once sensitive data are identified, internal procedures should be developed to help reduce the risk that the data will

Figure 1 *Baghdad, Iraq Presidential Palace high-resolution image from DigitalGlobe, data provider for Google Earth.*

GOVERNMENT EFFORTS TO REGULATE GEOSPATIAL DATA ARE LIKELY TO INCREASE. BY DEVELOPING AND IMPLEMENTING A COMPREHENSIVE SECURITY PROGRAM RELATING TO ITS SENSITIVE GEOSPATIAL DATA, A COMPANY WILL BE BETTER PREPARED TO MANAGE GOVERNMENT RELATIONS.

Figure 2

Google Earth image of Baghdad from the Web. Images in both Figures 1 and 2 are available to the public.

be used to harm national security. Clearly, a fool-proof system cannot be designed. However, there are steps that a company can take to help ensure that sensitive data are properly used. For example, commercial sales of sensitive data could require the approval of a few designated senior managers. These managers would be in a better position to identify unusual requests or patterns, as described in the scenario above. In addition, potential customers attempting to acquire sensitive geospatial data could be required to provide additional identifying information, as in other industries. If the data are being distributed via the Internet, for example, a password could be required to access sensitive data. The intent would not be to make such sales more difficult or cumbersome, but simply to ensure that greater scrutiny would be given internally to such sales.

Establishment of procedures on retaining records on customers and transactions: There are a number of good business reasons to have a complete and accurate history of transactions. However, in some industries, it is becoming a legal requirement to do so. For example, the Bank Secrecy Act and the Patriot Act require financial institutions to collect and retain certain records on customers and transactions so as to help prevent money-laundering and terrorism. Geospatial companies should consider similar measures with respect to sales of sensitive geospatial data. In the scenario described above, such a policy would have helped authorities identify other potential targets and suspects.

Introduction of employee training: Any security program should include a section on the training of employees. Each employee, particularly those in contact with customers, should understand the unique aspects of geospatial data and why special attention should be given to sensitive data. The training program should address the procedures described above to reduce risk, as well as the need to collect and obtain customer and transaction data. Employees should also be told which individuals within the company to approach with any questions or concerns.

Designation of compliance officer: A critical component to the success of any security program is the designation of a compliance officer. The compliance officer is responsible for reviewing the definition of sensitive geospatial data, and for monitoring the company's compliance with the procedures set forth in the security program. He or she would help prepare the training program for employees and would also be responsible for auditing the collection and retention of records.

The increased availability of geospatial data (particularly via the Internet) will result in numerous commercial and civil applications unrelated to national security. However, as the geospatial industry continues to grow, many people will focus on the potential security implications.

Key challenges in the commercial growth of the geospatial industry will be to avoid overly restrictive government regulation in the name of national security and to reduce exposure in civil litigation. One solution to both challenges is to adopt measures that are being used in other industries that handle sensitive data: a comprehensive security program, focused on sensitive geospatial data and tailored to address the company's needs.

Waterfront in Biloxi, Miss. following Hurricane Katrina, one of the most devastating storms in the U.S. in decades (Courtesy of Digital Globe).

Private Sector Grows as Earth Observation Stakeholder with GEOSS

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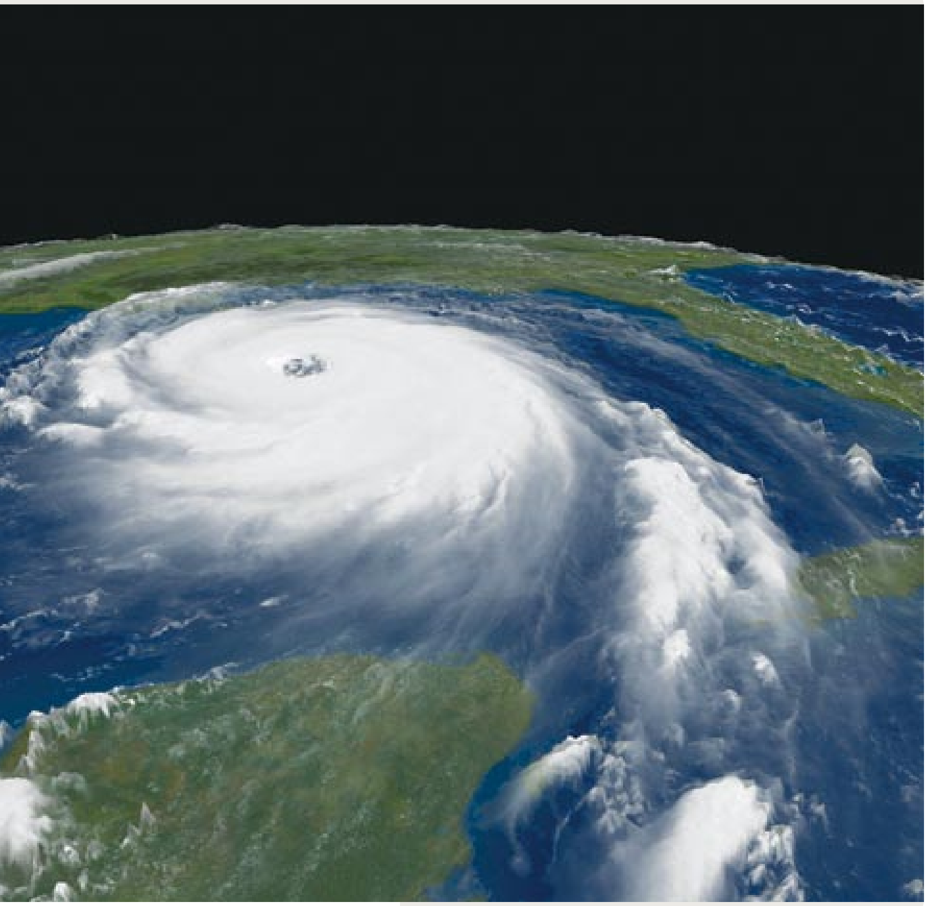
Balancing public and private sector interests in the area of environmental science has long been a tricky undertaking. There is no better example of the tensions that can develop than the controversy sparked by a recent Senate bill proposing to ban the National Weather Service (NWS) from issuing forecast products that could otherwise be provided by commercial weather services. The debate is confounded by the fact that most forecasts, whether from the NWS or a private company, are based on government-collected data.

Supporters say passage of the bill would force the NWS to concentrate on its core purpose — to forecast severe weather for the protection of life and property — while maintaining a financially viable private weather sector. Critics call the bill a veiled attempt to roll back drastically the amount of information the NWS is allowed to disseminate to the general public, thus paving the way for

> *Endorsed by scientists and government leaders around the world, GEOSS is expected not only to lead to improved weather forecasts, but also to support more informed decision-making in areas including natural resource management, public health, agriculture, transportation and emergency response.*



NOAA close-up satellite image of Hurricane Katrina taken at 11:45 a.m. EDT on Aug. 28, 2005, as the catastrophic hurricane moves closer to the U.S. Gulf Coast with highly destructive winds near 175 mph. Visible is Florida in the upper right corner, Cuba in the lower right, and Mexico below. The image is from the NOAA GOES-12 satellite.

commercial providers to fill the gap and, in effect, forcing the general public to pay twice for weather forecasts, once through tax dollars and again by patronizing private weather companies.

In sharp contrast to this discord is a cooperative endeavor by nearly 60 countries, more than 15 U.S. federal agencies and dozens of international organizations to integrate space-based, airborne and surface-based observations of the Earth for societal and economic benefit, and a related effort to facilitate public-private partnership in doing so.

Endorsed by scientists and government leaders around the world, the Global Earth Observation System of Systems (GEOSS) is expected not only to lead to improved weather forecasts, but also to support more informed decision-making in areas including natural resource management, public health, agriculture, transportation and emergency response.

Complementing this intergovernmental effort is a collection of private companies, academic institutions and nongovernmental organizations (NGOs) that have formed the Alliance for Earth Observations, an initiative of the nonprofit Institute for Global Environmental Strategies (IGES, Arlington, Va.). The purpose of the alliance is to involve the private sector in U.S. and international planning for Earth observations, especially as it relates to GEOSS.

The alliance was established in 2003 with the support of five leading aerospace companies — Ball Aerospace, Boeing, Lockheed Martin, Northrop Grumman and Raytheon — shortly after the United States hosted the first Earth Observation Summit. Highlighted by keynote addresses from Colin Powell, at that time U.S. Secretary of State, and other Cabinet members, the summit sparked formation of the Group on Earth Observations (GEO), an assemblage of government representatives from around the world charged with developing a 10-year plan to implement GEOSS.

Nancy Colleton, IGES president and alliance executive director, applauded the political will demonstrated at the summit (which IGES had a hand in organizing), but also recognized a critical need to promote private sector participation in the GEOSS process.

"Harnessing the wealth of experience that the aerospace community has in systems architecture and that NGOs have in developing applications, coupled with advancements from the IT and university sectors, is what will make GEOSS a reality," Colleton said. "This is the partnership that is needed."

Besides playing a significant role in developing the GEOSS architecture, managing and processing the vast amounts of data the system would collect, and creating observations-driven decision support tools, the private sector also stands to gain as users of the system. Improving weather forecasts by one degree Fahrenheit, for example, could save a large utility company as much as $100,000 per day, according to the National Oceanic and Atmospheric Administration (NOAA). Accurate and comprehensive data are important to many other industries as well, including the insurance industry, which depends on satellite images, climate records and other statistics when structuring policies and verifying claims.

In order to ensure GEOSS will address the needs of as many potential users as possible, the alliance has organized several forums and workshops in which industry experts have shared their ideas, needs and concerns with officials from the U.S. Interagency Working Group on Earth Observations (IWGEO). The IWGEO is a collection of 17 federal agencies that together have drafted a plan for developing and implementing the U.S. Integrated Earth Observation System (IEOS), the U.S. contribution to GEOSS.

NOAA Administrator Conrad C. Lautenbacher, one of the most outspoken proponents of GEOSS, and whose agency has a lead role in both the national and international efforts, says he welcomes and values input from the private sector.

"GEOSS goes well beyond a government science project. It is an operational system developed for end users, and without their input GEOSS would never have gotten off the ground." said Lautenbacher, who along with Colleton and another alliance representative testified before Congress in March of this year about the status and benefits of GEOSS. "In numerous venues, we continue to listen to the needs of many industries, and to factor those vital interests into the business of developing a global network."

Despite the current clash between public and private weather interests, there is in fact a history of public-private partnership in the area of environmental data. For example, in the past NASA has had agreements with commercial remote sensing companies to purchase ocean, land, climate and natural hazard data, and NOAA gets lightning observations from a private vendor. A 2001 report by the National Research Council expressed support for these types of arrangements, concluding that, under certain conditions, "it may well be in the public interest for the government to privatize data collection."

A similar spirit of cooperation has been echoed by the aerospace companies that founded the alliance. Traditionally fierce competitors, they have come together to form a united front because, they say, it is in the best interest of everyone in the private sector that GEOSS become a reality and move forward with input from a diversity of voices.

"We know that the combined resources, talents and influence of industry can be a very powerful tool," said Mike Wooster, director of Environmental Programs for Ball Aerospace. "In the early stages of a developing initiative as important as GEOSS, it is particularly important we work together to establish a program that can stand on its own — one from which we can all benefit."

NOAA Administrator Conrad Lautenbacher speaking at the U.S. Integrated Earth Observation System Public Engagement Workshop in early 2005.

With the recent addition of geospatial companies such as ESRI and MacDonald, Dettwiler and Associates, academic and research centers including Scripps Institution of Oceanography and Woods Hole Oceanographic Institution, as well as the conservation-focused NatureServe, the alliance is quickly becoming the unifying and broadly representative organization that its founders envisioned.

As the national and international processes continue to unfold — an office has now been established at the World Meteorological Organization in Geneva to house the GEOSS secretariat — Colleton hopes to maintain the momentum of GEOSS and the alliance with events like the upcoming Forum on Earth Observations II, to be held early next year in Southern California. Sponsored by the alliance, the forum, a follow-up to a similar meeting last fall, will provide a venue for members of the private sector to interact with government leaders and to identify observational data needs.

"Earth observations are truly central to everything, whether mitigating risk, managing natural resources, or forecasting air quality," Colleton said. "That's why it's important we work together to address as many needs as possible."

GEOSS "System of Systems" Depends on Standards

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How can 61 countries and 40 international organizations bring together their existing and new earth observation hardware and software systems to create a Global Earth Observation "System of Systems" (GEOSS) when the component systems are so different?

Like telephones, fax machines and web servers, the diverse systems in GEOSS will interoperate through published, free, universally adopted interface and encoding standards. The GEOSS 10-Year Implementation Plan and Reference Document (www.earthobservations.org) states:

"The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference given to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such systems have interfaces to the shared architecture."

"The Group on Earth Observations will establish, within 2 years, a process for reaching, maintaining, and upgrading GEOSS interoperability arrangements, informed by ongoing dialogue with major international programmes and consortia. Attention is drawn to the importance of using existing international standards organizations and institutes as a focal point for the GEOSS interoperability objectives as they relate to and use standards."

Among the standards necessary to build GEOSS are some that are already in use in commercial and non-commercial products, as demonstrated by members of the Open Geospatial Consortium, Inc. (OGC) at the International Geosciences and Remote Sensing Symposium, IGARSS 2005, in Seoul, Korea, in July 2005. The demonstration showed that earth observation data and online services are already accessible using industry standard, open interfaces. The demonstration utilized software components that use OGC Web Services interfaces (described below) in a scenario of damage assessment from the Indian Ocean Tsunami, Dec. 26, 2004.

The scenario began with a George Mason University client accessing a Common Alerting Protocol (CAP) message as a Geography Markup Language (GML) document from an Intergraph server that implemented OGC's OpenGIS Web Feature Server Specification (WFS). Landsat imagery was provided by the NASA-JPL Global Mosaic, which implements the OpenGIS Web Map Server Specification (WMS).

CAP, from OASIS (Organization for the Advancement of Structured Information Standards, an e-business standards organization) is a simple but general format for exchanging all-hazard emergency alerts and public warnings over networks. The OpenGIS GML Specification (all the OpenGIS Specifications are products of the international consensus process managed by OGC) defines a data encoding in Extensible Markup Language (XML, a simple, extensible text format from W3C) — a "namespace" — for geographic data and its attributes. WFS describes data manipulation operations on OGC Simple Features (e.g., points, lines, and polygons) so that servers and clients can communicate at the feature level. WMS provides uniform access by Web clients to maps rendered by map servers on the Internet.

FIG 2

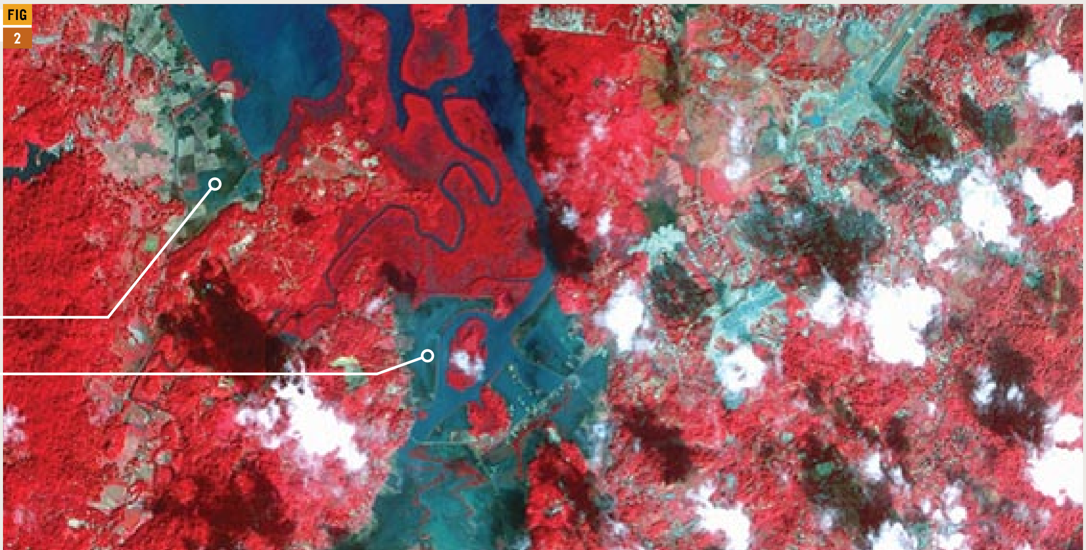

FIGURE 2 *Value-added product showing areas of the Andaman Islands affected and flooded by the tsunami. Image from SPOT Image, Inc.*

FIG 1

SERVICE CHAINING CREATES ON-DEMAND PRODUCTS

The George Mason University client accessed layers of tsunami damage summaries provided by a server that implemented WMS. That server was developed by DM Solutions as part of a project with several East Asian Universities.

Next, imagery was accessed from a Spot Image server — via an interface implementing the OpenGIS Web Coverage Server Specification (WCS) — to see additional detailed damage from the tsunami. (WCS extends the WMS interface to allow access to geospatial "grid coverages" that represent values or properties of geographic locations, rather than simple maps, or pictures.)

A chain of OGC Web services was invoked using standard web service chaining mechanisms to produce a value-added product. See ***Figues 1*** and ***2***. The European Space Agency System Support Environment managed the workflow of accessing the Spot Image WCS and invoking PCI Geomatics' implementation of the OGC Web Coordinate Transformation Service (WCTS) discussion paper (a specification that has not yet been adopted by the OGC membership). (The WCTS provides a standard Web-based way for software to specify and access coordinate transformation services for use on specified spatial data.) OGC specifications can be downloaded from www.opengeospatial.org/specs/?page=specs.

More than 270 products are registered as officially implementing OpenGIS Specifications. (See www.opengeospatial.org/resources/?page=products.) As demand grows for interoperating products like these, more product developers add open interfaces. Many agencies are boosting demand by putting standards requirements in their Requests for Quotes for software procurements. This progress advances the GEOSS vision.

The ad-hoc Group on Earth Observations Architecture sub-group has a plan that includes a task to select standards, but none have been selected yet. Specifications used in the IGARSS 2005 demo are candidates for consideration as part of the technology layer of the GEOSS architecture.

Other standards that are under consideration include CORBA (Common Object Request Broker Architecture), WSDL (Web Services Definition Language), ebXML (electronic business XML), UML (Unified Modeling Language), and ISO/IEC 11179, Information Technology – Metadata Registries.

Remote sensing organizations from many countries have contributed to the development of OpenGIS Specifications, and OGC has worked to harmonize these specifications with evolving internet and World Wide Web standards. Thus, much of OGC's work addresses the needs of the GEOSS community. Regarding the OGC demo during IGARSS, Al Gasiewski, President, IEEE Geoscience and Remote Sensing Society said, "It is encouraging to see such rapid progress in the development of multi-source open web-based software tools designed with the needs of GEOSS users in mind."

However, the work is not finished. Important technical capabilities are still missing and some communities in the Earth observation world have not made their requirements known in OGC or in other relevant standards organizations, so existing and in-progress specifications may not meet their needs. Broad participation by GEOSS communities in standards efforts will be necessary if GEOSS is to succeed, because only by participating in standards efforts can organizations shape standards to suit their needs.

FIGURE 1 ***Open interfaces enable web-based "service chaining." Value-added information products are produced by automated procedures involving different data servers and process servers on the web.***

Imagery and GIS

A New Approach to Municipal Security

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By the morning of Sept. 14, 2001, large dump trucks filled with sand surrounded Baltimore's City Hall. Members of the Police Department's elite Quick Response Team somberly stood watch to the flanks of the dais as Mayor Martin O'Malley led the city in prayer and mourning for our neighbors to the north and south.

Something was different. The world had not changed, but our perceptions and priorities had.

As mourning gave way to response, the need for increased security planning would collide with the nascent geospatial data capabilities of the City of Baltimore. Many policy changes and actions would occur in the coming months and years in the cause of homeland security, but discussion of most must be left for another time and place. Here, we shall focus on remote sensing and imagery in the City of Baltimore and their roles as enablers in a new approach to municipal security.

By the end of the 1990s the city had developed a modest Geographic Information System (GIS) capability. Originating within the Bureau of Water and Wastewater, GIS had begun its life as a tool for managing underground utility data. Yet as the 1990s gave way to the new millennium, the dataset expanded and included other planimetric features such as street centerlines, land parcels, and such cultural features as schools, museums, and churches. This dataset, together with the aerial imagery used to create it, would serve as the basis for the new methods of municipal and homeland security planning.

At a basic level, the city's aerial orthophotography serves as an enabler at the tactical and strategic levels of operations, yet that same imagery enables the creation and maintenance of the GIS data used for other forms of analysis and planning. The existence of geospatial assets has enabled a new approach to homeland security for the City of Baltimore.

Imagery, even without the direct use of GIS data, has proven quite valuable to the city in security matters, especially during events and operations. While direct overhead imagery can be helpful, Baltimore's fire and police departments, as well as other emergency responders have found that oblique imagery proves more valuable. Oblique imagery allows users to have a rotating 45-degree view of a city location, enabling emergency personnel to determine the size, configuration, and access during fires or other serious events, and to make suitable plans without sending individuals into harm's way. See **FIGURES 1** and **2**.

In the past it was necessary to send firefighters or police officers into potentially hazardous situations to analyze the safety of an area. Now it can be done from a command vehicle equipped with a laptop and the city's Pictometry software and data.

Also valuable during operations are the various closed-circuit TV cameras installed throughout the city. Operating under the CitiWatch program, these cameras are used mainly for crime fighting purposes. However, some are dedicated to the monitoring of potential sites of terrorist activities. In conjunction with other cameras operated by the Department of Transportation for traffic monitoring, red light enforcement, and snow clearing operations, these cameras provide a kind of real-time intelligence lacking in other products. No single type of remote sensing data can serve all purposes, but these various sources acting in concert and across agencies result in reduced risk to both emergency responders and the citizens of Baltimore.

Geospatial data provides the opportunity not only for increased situational awareness during operations but also for improved planning beforehand. The same sources described above can be used for identifying evacuation chokepoints, security vulnerabilities, and potential deployment plans before an event occurs, and such uses do occur by the Mayor's Office, Office of Emergency Management, and other agencies of the city. However, at this more "strategic" level of planning, non-imagery geospatial data and its concomitant analyses come into their own.

Various forms of geospatial data have been created from overhead imagery data for the city. These data can then be used for such things as plume analyses, force deployment patterns, and the integration of geospatial information with non-geospatial information through the use of geodatabases. Thus, GIS acts as a force multiplier for the city's imagery data. Not only is it possible for imagery to be used during planning and operations, the GIS data derived from such imagery allow for an even greater array of analysis, planning, and operational efficiency.

Most geospatial data, like other forms of information, can and should serve multiple uses, but this has never been as apparent as it has been in the post-9/11 era. There will always be security-specific data such as critical

FIGURE 1 *High-resolution oblique image of the Washington Monument from the City of Baltimore's Pictometry Imagery Warehouse, as would be downloaded and used by the city's first responders*

Figure 1

FIGURE 2 *Pictometry Image of Baltimore's Lauraville Neighborhood that can be used by the city's first responders*

The existence of geospatial assets has enabled a new approach to homeland security for the City of Baltimore.

infrastructure that need to be a part of any emergency response framework. However, high resolution imagery, as well as common GIS layers such as water supply networks, railroads, and landuse data (which all have obvious municipal planning applications), have a potentially greater value in the context of homeland security. As part of pre-event planning, and also during actual events, data such as these often serve an even more important function than some of the security-specific data. This dual use nature can also inform the requirements for future data acquisition. In the past, imagery datasets or GIS landbase update requirements would be defined by engineering and planning needs, not by security considerations.

A series of recent developments in the geospatial data realm has led to a greatly increased accessibility of imagery data and other resources. The USGS's National Map project, Google Maps, and Google Earth have put a wealth of imagery and data at the fingertips of anyone, including budget-strapped municipalities. Additionally, the increasing availability and robustness of open source software further increases a jurisdiction's accessibility to IT and imagery security solutions. Combinations of cheap hardware, free software and free data mean that cost-prohibitive imagery solutions may be increasingly rare. Although the budget in Baltimore may feel tight, this is especially true for more rural jurisdictions whose imagery and GIS budgets can be dwarfed by those of major market cities.

The City of Baltimore made a great stride in accessibility of imagery data with the introduction of Pictometry in the Spring of 2004. A fairly simple desktop client, and the fact that basic users can easily relate to and interpret features in oblique imagery, mean non-GIS and even non-technical people are able to access and use these data with average PCs. In the past, imagery and maps generally would be available only during major incidents when GIS and other personnel reported to the city's Emergency Operations Center. Now, there is no need for highly trained GIS and Imagery experts with high-end workstations to place important data into the hands of decision makers in a timely fashion. A firefighter at the scene using a laptop can accomplish the same tasks. Thus, geospatial data can be leveraged during smaller, less serious events, as opposed to being limited to large-scale catastrophes.

All of these technologies will continue to mature, become more complex, and ultimately converge. Therefore, it is increasingly important that some basic level of accessibility to common users be maintained if we are to avoid the risks outlined in Alvin Toffler's classic treatise, *Future Shock*. Although much of Toffler's work was alarmist and even outrageous, it is difficult to deny that increasing specialization in many parts of the IT realm can lead to certain planning and logistical difficulties for security events.

By keeping imagery data in the hands of both decision makers and first responders, we can greatly increase the value of these data while improving our responses during security events and praying that a need for such responses may never come.

A Foam-board Future for Palestine

May Be Realistic Now After Israel's Withdrawal from Gaza

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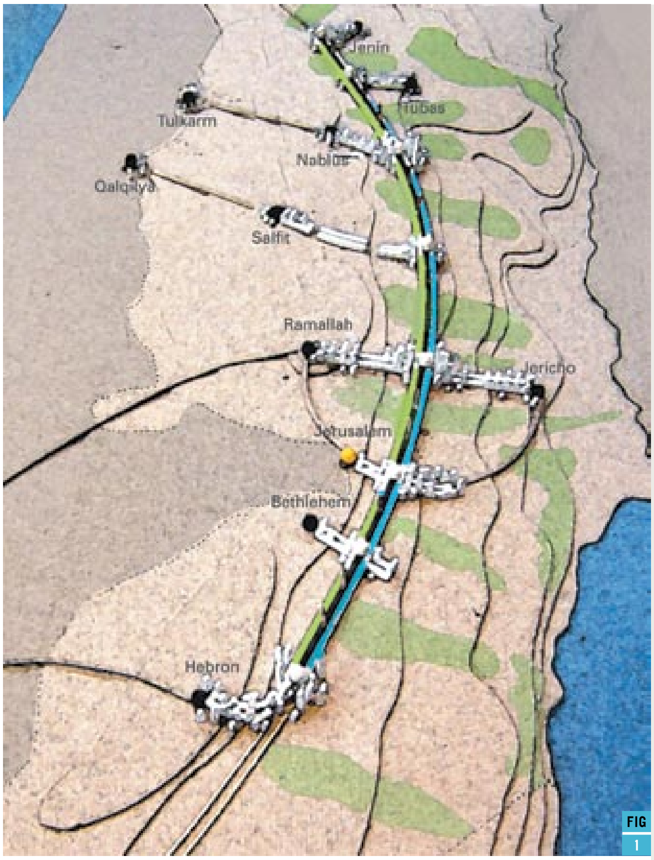


FIG 1

Figure 1 *Cardboard model of the Arc, courtesy of Suisman Urban Design*

Within a nondescript box made of skillfully cut foam sheets in a small urban design studio in California lies a future Palestinian state. A tiny train line makes its way from a miniature Gaza Strip to a polystyrene West Bank, connecting the region's historic cities.

The region's 3.5 million residents, too small for the designer's hands to depict, will travel along this high-speed railway to visit their newly connected families and to commute to their future jobs. Electricity, broadband connection and water will follow the railway's graceful arc, creating an infrastructure for a state that is as yet unsustainable.

I stumbled onto this unassuming vision of the future Palestinian state (see ***Figure 1***) while working on a documentary being produced as part of a geospatial awareness program through a partnership between KOL Networks and the U. S. Department of Labor. Little did I know, my pre-production research on urban planners' use of satellite imagery would lead my crew's video cameras from a commercial satellite imagery company outside Washington D.C. to an urban designer's studio in Southern California, and finally to two pieces of disputed land in the Middle East.

What struck me immediately was the potential that this fragile construction of modeling materials and creativity held for the Middle East, where in the midst of the volatile Palestinian/Israeli conflict, most efforts are focusing on the details of politics, not reconstruction. However, thanks to a $2 million study led by the Rand Corporation (www.rand.org/palestine, a non-profit think tank), Doug Suisman of Santa Monica-based Suisman Urban Design (www.suisman.com/palestine) has been given the chance to outline what could happen after the political climate cools and the departure of security forces makes room for construction crews. Due to my documentary mission, I was able to ask him about his creation in person. Suisman's plan is appropriately called the Arc, referencing the plan's arc-like transportation and infrastructure backbone, which has given Palestinians and Israelis a tangible goal to visualize as they push toward the peace process.

The Arc is unique in that it looks ahead to the details of a possible future Palestinian state while the current political climate makes the existence of such a state seem tenuous at best. "People don't often talk about the day after peace; they talk about the establishment of such a state," Suisman explains to our cameras. He goes on to report the common reaction to his vision as one of surprise and enthusiasm at the Arc's potential, which ultimately gives way to hope for most Palestinians who have viewed his proposal.

When I discovered that Palestine's deputy finance minister, Jihad al Wazir, cried tears of joy upon seeing the Arc model, I knew I had found the focus of my documentary — a typically standard land-use study poised to affect the region in dramatically atypical ways.

IMAGING PALESTINE'S CHALLENGES

With the current positive direction of Israeli/Palestinian politics and with Israel's recent remarkable withdrawal from the Gaza Strip, Doug Suisman's miniature mockup is more of a possibility than he or the Rand Corporation ever imagined. If the Arc or any other redevelopment plan gets the green light, a legion of designers, engineers, and builders will need to understand and visualize the challenges that modern Palestine's geography presents, requiring numerous and detailed remotely sensed data of the region (see ***Figure 2***).

Palestine's antiquity is one of the challenges that will confront future designers and construction crews, and Suisman has dealt with this in designing the Arc. The new Palestine will have to be built atop a jumble of

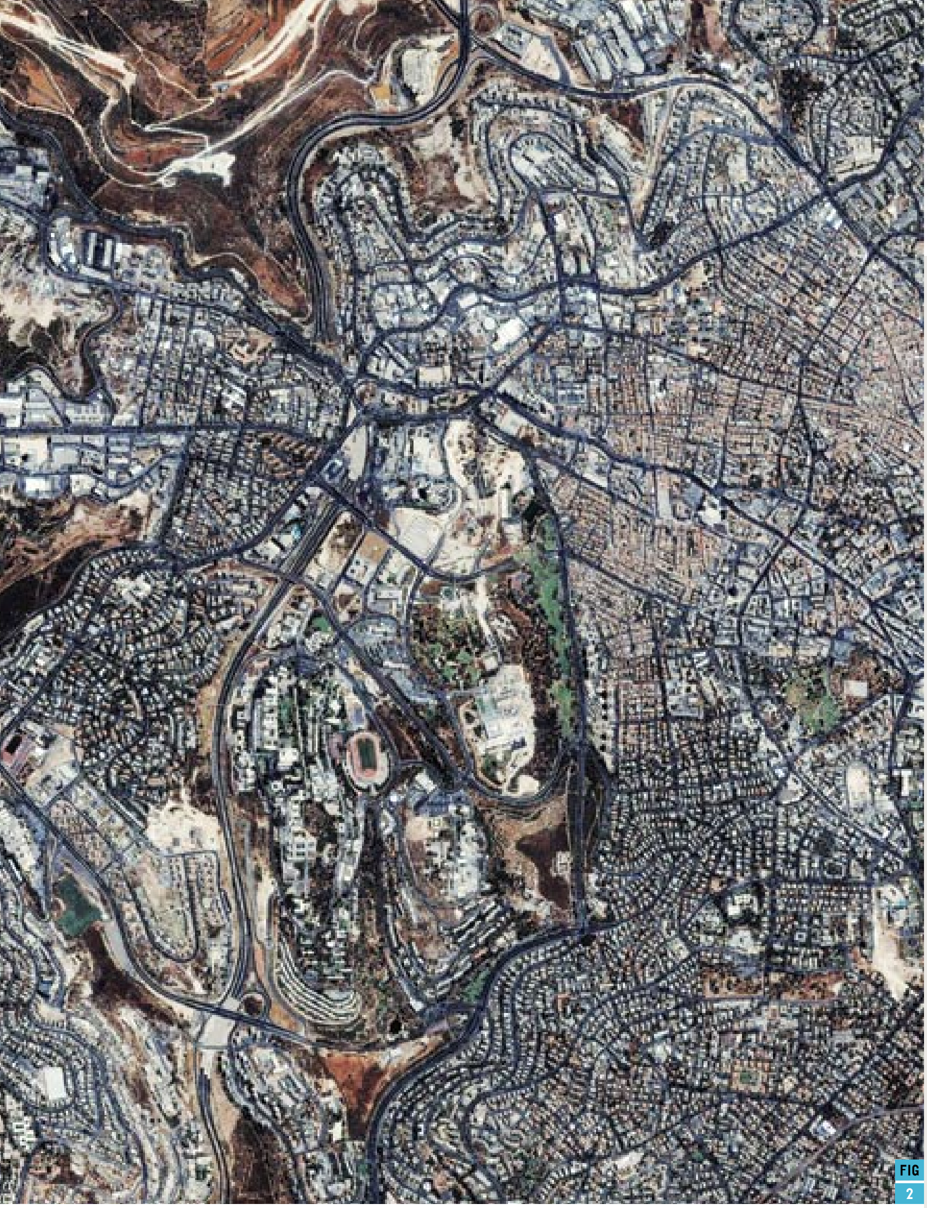


FIG 2

ancient cities and historic sites, and even refugee camps while still respecting the inhabitants' deep connections to the region's history and tradition (see ***Figure 3***). A world away in his Southern Californian studio, Suisman explains that "efforts to build a new city from scratch generally are not successful."

By studying commercial satellite imagery, Suisman has been able to observe "a particular tradition of urban form in Arab cities which is very sustainable, compact, based on pedestrians rather than automobiles and is very much adapted to the climate." Rather than deny Palestine's roots and its years of development, Suisman stresses that a successful plan for Palestine's future must incorporate the intrinsic cultural, archeological, economic, human and psychological values of the West Bank and Gaza's historic cities (see ***Figure 4***).

Suisman was further challenged by his relatively limited knowledge of the region, which was one of the primary reasons Rand chose him. "He saw the potential in a way that maybe only a naïf can," explained Steven Simon, a principal in the Rand study, in a May 15, 2005, New York Times article. Detailing how he overcame this knowledge gap, Suisman noted that his team was "reliant on maps and images to paint the picture – to construct the landscape in our minds and in our imaginations." His team's study of these images included "everything from the built-up urban areas [and] the location of water resources, to power lines and archeological sites." Through these remotely sensed images, Suisman received a logistical understanding of Palestine without having been discouraged by the realities of a seemingly insurmountable political situation and years of failed peace.

From his studio at the project's start, continents away from broken promises, treaties and cease-fires, Suisman began analyzing Gaza and the West Bank's topography, trying to find a way to link the two non-contiguous pieces of urban sprawl. "The Arc began as a recognition that there was a form in the landscape which we call a natural arc formed by a ridgeline," Suisman tells me as our cameras roll. Images from the Applied Research Institute Jerusalem's Atlas of Palestine offered a portrait of the topography from a number of perspectives. Suisman matter-of-factly states that "without the sophisticated imagery, we couldn't have constructed a sufficient 3-dimensional model (see ***Figure 5***) to have produced anything useful." This high-tech and highly visual imaging technology will undoubtedly play a valuable role in understanding the region's current condition, helping planners reconcile Palestine's past with its future.

In similar reconstruction scenarios, 1-meter resolution images from commercial satellites, such as IKONOS, OrbView-3 and QuickBird, would support the construction efforts, giving planners the highest quality data available. Unfortunately, due to the Kyl-Bingaman Amendment to the U.S. National Defense Authority Act of 1997, this high-resolution imaging capability is prohibited from capturing data of Israel, including the West Bank and the Gaza Strip. Mark Brender, Vice President of Corporate Communications and Washington D.C. Operations for IKONOS-operator Space Imaging, explains that "anytime we have imagery over Israel, we have to resample it — some say 'fuzz it up' — to 2-meter ground resolution" before delivery to the client. As a result, the future developers of Palestine will be forced to use the equivalent of less-than-ideal 2-meter resolution technology which contains one-fourth the information, thus hindering design and construction efforts.

This "fuzzing" is required only when imaging Israel, leaving imaging of any other sensitive areas of the Earth's surface unrestricted. This was illustrated for my production crew in the Space Imaging office, as we were shown images of Bush's Crawford Ranch, Area 51, and Iraq's green zone at 1-meter resolution. According to Brender, "There are no imaging restrictions anywhere else in the world, other than Israel."

This inconsistency piqued my interest and further

FIG 3

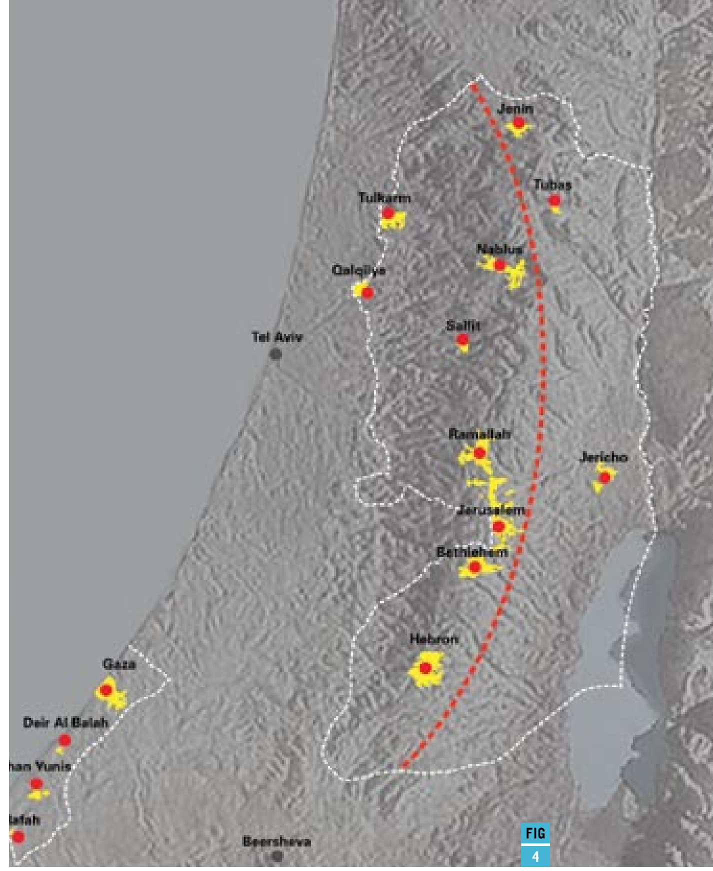
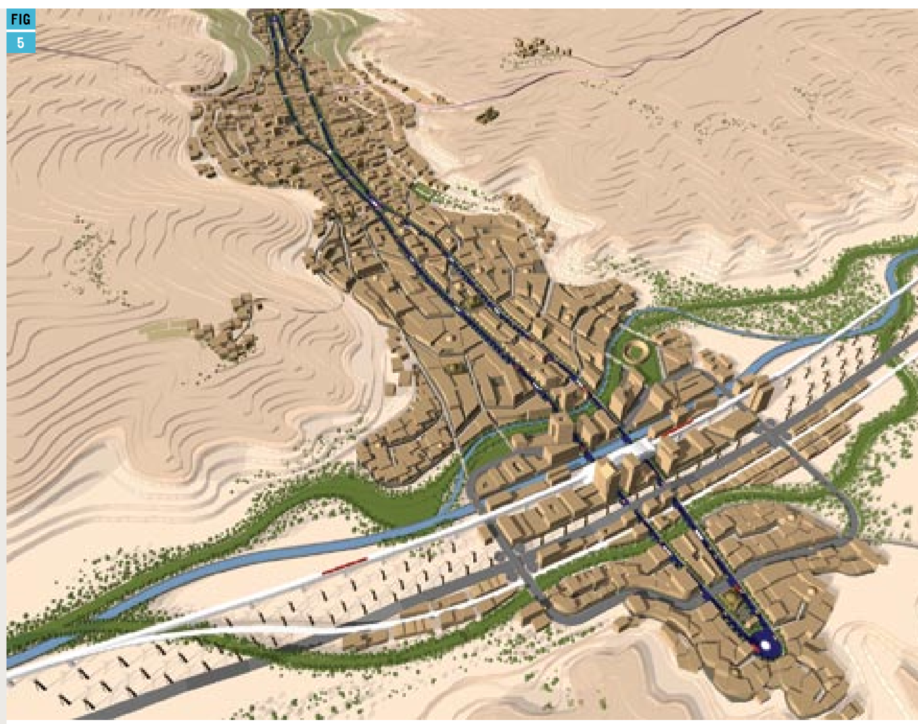


FIG 4

FIG 5



spurred my research with the question: why was the Kyl-Bingaman Amendment put into legislation? Brender explains, “Before we launched the IKONOS satellite in September of 1999, Israel saw this age of transparency coming from commercial satellites and they wanted to limit in some capacity the ability of these satellites to see Israel in 1-meter ground resolution.” The amendment states that no commercial imaging company can image Israel at any resolution that is better than that of any other country’s remote sensing satellites. The Commerce Department has determined that resolution to be 2-meters.

Repealing this amendment would help in furthering the growth and development that benefits all countries in the region. With estimated costs of redevelopment of Palestine hovering at $33 billion, having the best data available will help in keeping the financial burdens on the international community to a minimum and in allowing the project to move forward as quickly as possible. “I think it would be wise to have 1-meter resolution available for GIS [analysts], city planners and infrastructure development in Gaza,” says Brender, adding, “There are currently no plans to repeal this amendment. Perhaps government officials should re-evaluate the merits of this old amendment so that the Palestinian Authority can use the best U.S. product to support redevelopment efforts.” Perhaps by the time bulldozers are ready to break ground, arrangements will be made to allow planners to use unadulterated data.

INSPIRING THE GREATER REGION

Assuming that the political and legal hurdles are overcome, the international community secures the Arc’s estimated $6 billion price tag and Palestine becomes a

Figure 2 *IKONOS satellite image of Jerusalem, courtesy of Space Imaging*

Figure 3 *Still image from Geospatial21’s documentary, courtesy of KOL Network*

Figure 4 *Palestine’s historic cities, courtesy of Suisman Urban Design*

Figure 5 *Digital model of the Arc, courtesy of Suisman Urban Design*

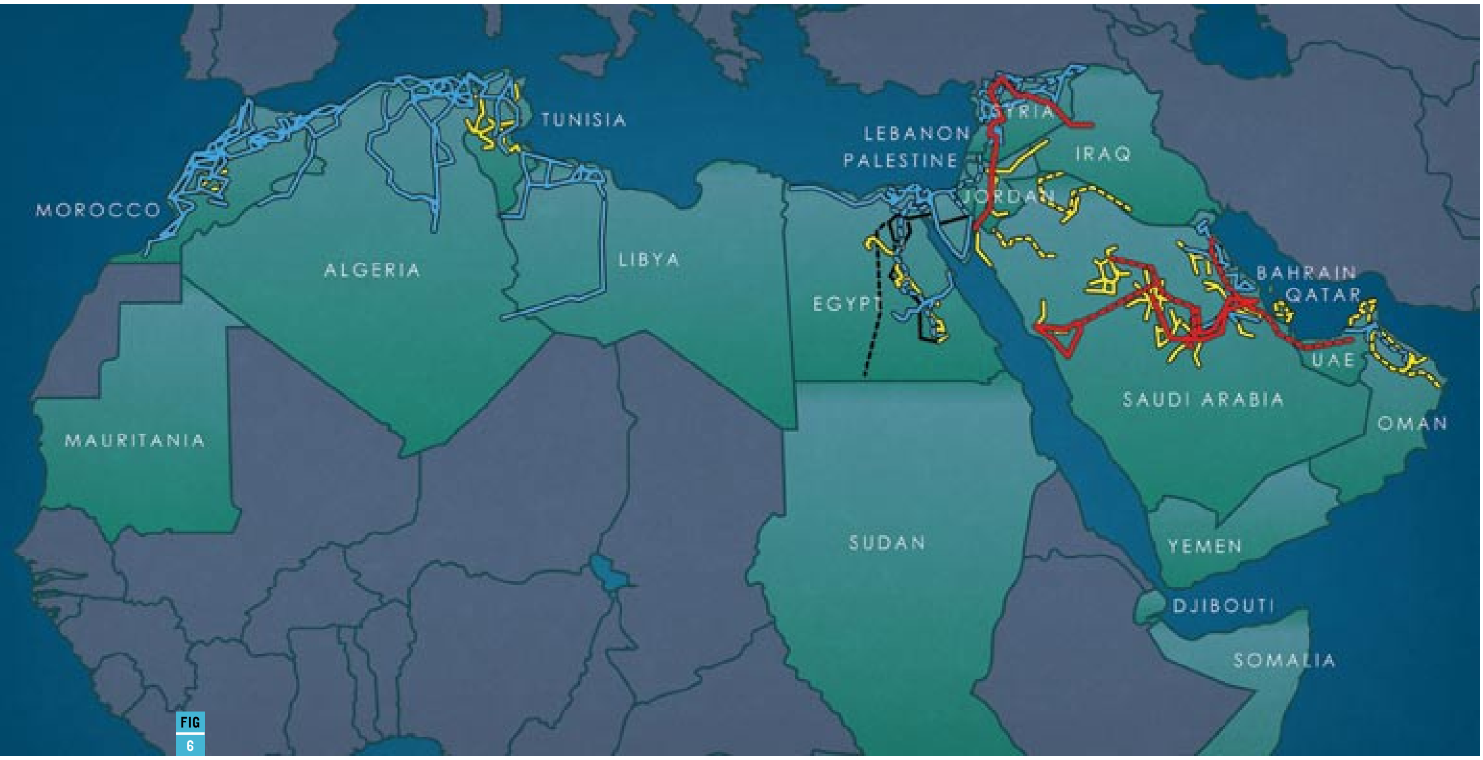


FIG 6

Figure 6 *Pan Arab Research and Education Network, courtesy of KOL Network*

thriving and peaceful metropolis, the success could inspire redevelopment throughout the Middle East. "It's hard to believe that it would not serve as a model for others in the region seeking to improve the lives of their own people," predicts Suisman.

There's reason to believe the Middle East may already be at the start of a redevelopment trend. In fact, my research for the documentary led me beyond Palestine to the proposed Pan Arab Research and Education Network (PAN) and to the rapid development of Dubai with its World and Palm Island constructions, not to mention the impending reconstruction of Iraq. The PAN initiative intends to link the major educational institutions in the Middle East and North Africa region (see ***Figure 6***). Douglas Hull, an author of the PAN feasibility study and featured expert in the documentary, stated that the planning and implementation of the PAN will require the best use of modern geospatial tools.

Were the current infrastructure improvements to expand into a grand redevelopment phase of the greater surrounding region, GIS and remote sensing usage would increase, and in-region geospatial workforce demands would subsequently grow likewise. Before this widespread redevelopment, political cooperation, and collaboration become feasible, however, there is a great need for training a new generation in the areas of remote sensing and its uses in urban planning. Programs like the KOL Network's Geospatial21 and Career Voyages (www.careervoyages.gov) are aimed specifically at stimulating awareness and excitement in students to acquire training in these fields. Without adequate numbers of properly trained technicians and specialists, development time will slow, increasing security and terrorism risks. Outdated cartoon-like maps of the 20th century are not the tools to use in this massive undertaking.

Most of the people in the Middle East are under the age of 24. All these young people are going to need jobs and places to live. Projects like the Arc are possibilities for providing both the jobs and the residential, commercial, and industrial infrastructure to support this rapidly growing region. It is my hope that someday soon, this story, told through my production crew's cameras, will educate Palestinian students on how geospatial tools are being used to better their lives and how a geospatial career can empower them to change their world for the better.

Back in the Suisman Urban Design office where the crew is packing up camera equipment and lights, I sit down with Mazen Zoabi, a visiting Palestinian GIS researcher on a temporary assignment at the studio. Soft-spoken but confident, he tells me how satellite imagery helps him document the water shortage situation in Palestine for the Rand Corporation's study. Here is a young man who has learned the skills to effect change in his homeland. "Living there is not easy, but every time I leave the region, I miss it," he states. For him, a future Palestine is not an urban planning challenge to be solved, but an emergency — one to be met with the powerful tools of remote sensing.

Imaging Notes

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