PATHFINDER

The Geospatial Intelligence Magazine

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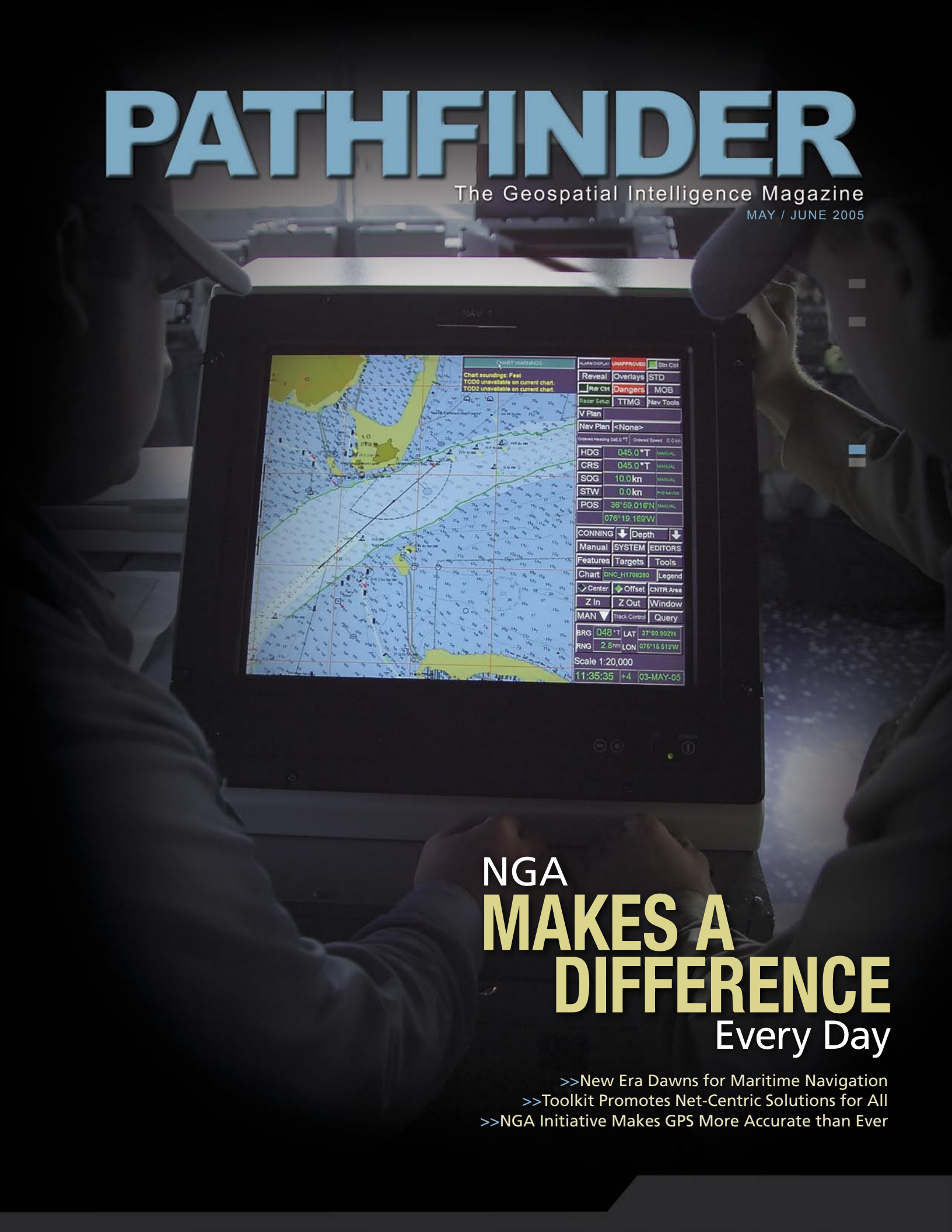

NGA MAKES A DIFFERENCE Every Day

Contents

PATHFINDER
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ON THE COVER

Navy QM[2] Dominic Genger and Ensign Tim Shanley on the bridge of the cruiser *USS Cape St. George* (CG-71) use NGA's Digital Nautical Chart (DNC©) in an electronic chart display and information system to navigate during tests off Virginia this spring. The Navy is moving toward using DNC© for navigation in all of its ships. Laura Garber designed the cover. Rob Cox took the photo.

GETTING PUBLISHED

All members of the geospatial intelligence community are welcome to submit articles of community-wide interest. Articles are edited for style, content and length. The copy deadline is the last Friday of the third month before publication. For details on submitting articles, e-mail the Pathfinder. Our address is pathfinder@nga.mil.

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GEOINT makes a difference every day.

Letter to our Readers

Every day, geospatial intelligence (GEOINT) makes a difference, not only for NGA's traditional stakeholders, the military and Intelligence Community, but also for people in motion everywhere. That's the theme of this Pathfinder, as we continue our yearlong look at ways in which NGA and the GEOINT community are making a revolutionary difference.

In the last issue, we showed you why this new discipline matters from the vantage point of warfighters. While the power of GEOINT boosts their efforts to achieve dominance in any situation, the guidance GEOINT provides in "getting there" as well as understanding "where it's at" is no small matter for all of us. So, it seems logical to focus in this issue on navigation as an end use for GEOINT.

First, we look at Digital Nautical Chart (DNC®), an NGA product one Navy captain called as revolutionary as "going from sails to steam." DNC® transforms navigation and more, providing geospatial data for electronic navigation systems that become operational in the Navy later this year.

Next we look at another product NGA pioneered, the Commercial Joint Mapping Toolkit. Technology used in its development expands the possibilities of geographic information systems for everyone, as the toolkit demonstrates the ability to deliver vast amounts of geospatial information via the Internet to users with very limited equipment.

Both DNC® and the toolkit depend on the Navstar Global Positioning System for reference coordinates that empower users to apply information to their situation. Again, NGA is intimately involved in a revolutionary navigational system, as Tom Creel, NGA's Deputy Program Manager to the GPS Joint Program Office, points out in his article, "NGA Initiative Makes GPS More Accurate than Ever."

NGA is playing a leading role in the nation's increasing global efforts, from supporting security efforts at the Olympics to aiding humanitarian efforts in the Darfur region of Sudan. We take a look at NGA's extensive support to the tsunami relief efforts from the vantage point of an imagery analyst who was personally involved.

Our last feature brings together some of the varied possibilities of GEOINT in a single community-service project undertaken by one of our geospatial analysts. I hope Lee Mitchell's article on how he and NGA are helping conserve a unique "biobay" in Puerto Rico will stir your imagination, as it did mine.

In the July-August Pathfinder, we'll take up the same theme—"How NGA Is Making a Revolutionary Difference"—but with a different end use: homeland defense.

Mark Schultz
Director, Office of Corporate Relations

On My Mind

Intelligence Preparation of the Environment

How NGA Is Preparing for Future Intelligence Challenges

By Lt. Gen. James R. Clapper Jr., USAF (Ret.), Director, National Geospatial-Intelligence Agency

On May 2, Director of National Intelligence (DNI) John Negroponte addressed the NGA work force and challenged us, along with the larger Intelligence Community, to use "fresh thinking" when handling intelligence problems. His point: although intelligence is "not a panacea" for the diversity of threats the United States faces in the 21st Century, we must raise our performance level on intelligence issues so we can help meet our nation's challenges in the new century.

At NGA, we are already injecting fresh thinking into our operations. We are always considering new processes and methods for producing richer geospatial intelligence (GEOINT) for our customers. Our work to incorporate Intelligence Preparation of the Environment (IPE) into our intelligence-analysis doctrine and training is a prime example.

Fostering Predictive GEOINT

What is IPE? Put simply, it is an analytical approach to foster predictive GEOINT at global, regional and local levels to a diverse customer base throughout the spectrum of operations from peacetime through wartime. It is a systematic four-step process to help our analysts produce both written and visual GEOINT products that can help solve a variety of intelligence problems. *Define the environment, define the effects, evaluate threats or possible hazards, determine alternate courses of action*—these are the four steps of IPE. Though our analysts have always used aspects of these steps in their work, IPE formalizes this thought process and provides a more uniform system through which each analyst operates.

"Perhaps the most intriguing benefit of IPE is its ability to help move NGA from historically based analysis to predictive analysis."

I was first introduced to a form of IPE during my tenure as Director of Intelligence for U.S. Forces, Korea some 20 years ago. That form was called Intelligence Preparation of the Battlefield (IPB), and it later expanded to become Intelligence Preparation of the Battlespace. IPB was the process by which intelligence personnel provided commanders and warfighters with information concerning the threats and environmental factors (weather, terrain, etc.) that might affect missions. Today, IPB continues to provide critical information to Joint Forces to help drive military decision-making and save military and civilian lives.

From my perspective, perhaps the most intriguing benefit of IPE is its ability to help move NGA from historically based analysis to predictive analysis. During the Cold War, customers asked analysts at NGA's predecessor organizations to locate and identify what were then largely static enemy forces, equipment and facilities. Analysts approached these locational questions by concluding that since intelligence showed that enemy forces were at point X yesterday and since the enemy usually moved as a part of a large, slow-moving group or battalion, that adversary would likely still be at point X—or at least somewhere in the vicinity of X—on the following day. To locate a building or facility of interest, an analyst might also

use history to draw conclusions. A building sitting at location Y today would probably still be sitting at location Y tomorrow since buildings don't usually move or change, although the activities occurring within them might.

But the Cold War has ended and the threats to our nation have dramatically changed and multiplied. Some remain unknown. In the Global War on Terror, intelligence analysis based largely on historical analysis cannot help locate terrorist cells that change location by the hour—or their terrorist facilities buried underground. The goal of IPE is to give analysts a framework by which they can quickly prioritize and structure their efforts and take better advantage of new and enhanced visualization tools to provide tailored and timely GEOINT to their customers. IPE helps NGA analysts as a unit ask the right questions so they can provide accurate answers to GEOINT questions *and* also predict what the answer may be tomorrow, next week, and possibly beyond next week—even when referring to fast-moving targets, equipment and cells or deeply camouflaged facilities and activities.

"NGA is playing a decisive role in performing the 'Fresh Thinking' that the DNI has rightly asked for us all."

IPE Process

As an example, I will explain how NGA analysts used many elements of the IPE process to support tsunami relief operations. I do not suggest that all analysts consciously and at all times adhered to the IPE doctrine as they provided this superb support. Rather, I am illustrating how we used many aspects of IPE steps *one through three* in our work for this effort:

- NGA analysts used imagery and mapping products to depict the countries, towns, villages, and/or cities affected by the tsunami.

  (Step one—Define the environment.)

- Analysts considered the effects of the tsunami tidal wave and its resulting earthquake on the terrain, infrastructure, landing zones and other key facilities in the region to produce First Look reports, cables, and the NGA Imagery Intelligence Brief.

  (Step two—Define the effects.)

- Analysts looked at earlier tsunamis to determine possible aftershocks that could affect relief operations in this current situation. They also used population and ethnic overlays, demographics, and other products to make predictions about possible insurgent or terrorist activity.

  (Step three—Evaluate threats or possible hazards.)

The result? NGA played a crucial role in helping to assess the damage caused by the tsunami, and our Agency continues to be a key player in relief efforts.

Future NGA support to operations would include IPE step four, developing courses of action. For the tsunami scenario, this would include integrating information from steps one through three to develop potential courses of action and providing recommendations on the best courses of action for conducting relief operations by air, sea and land.

We can all agree that the Intelligence Community must transform. But to do so, we cannot stop at reorganization. Nor can we simply review and/or scrutinize the intelligence we produce. We must examine the *processes* we use to produce the intelligence we send forward to our nation's leaders, our warfighters, and our other customers.

Continued on page 26

New Era Dawns
for Maritime Navigation

By Matt Reiner and Jeff Whittaker

Thanks to the Digital Nautical Chart (DNC®), the world's first and only worldwide digital nautical chart, a revolutionary era in marine navigation is upon us. DNC® was created over the last 15 years by NGA for the Navy and provides combat support, situational awareness, and marine navigation superior to that of traditional paper charts. It also improves efficiency by reducing manpower requirements and human error.

Automated position keeping—the ability to always know where you are, not where you were—will provide the Navy a previously unattainable navigational edge and tactical advantage. DNC® can be continually, automatically updated allowing for the ability to navigate in real time. It also allows the Navy to integrate all navigational and weapons systems aboard ship, build a common picture for those who need it, and blend sonar and radar with navigation depiction. Due to the efficiency of DNC®, all of the above-mentioned advantages can be accomplished with a reduction in onboard personnel, not to mention storage area previously used for paper charts.

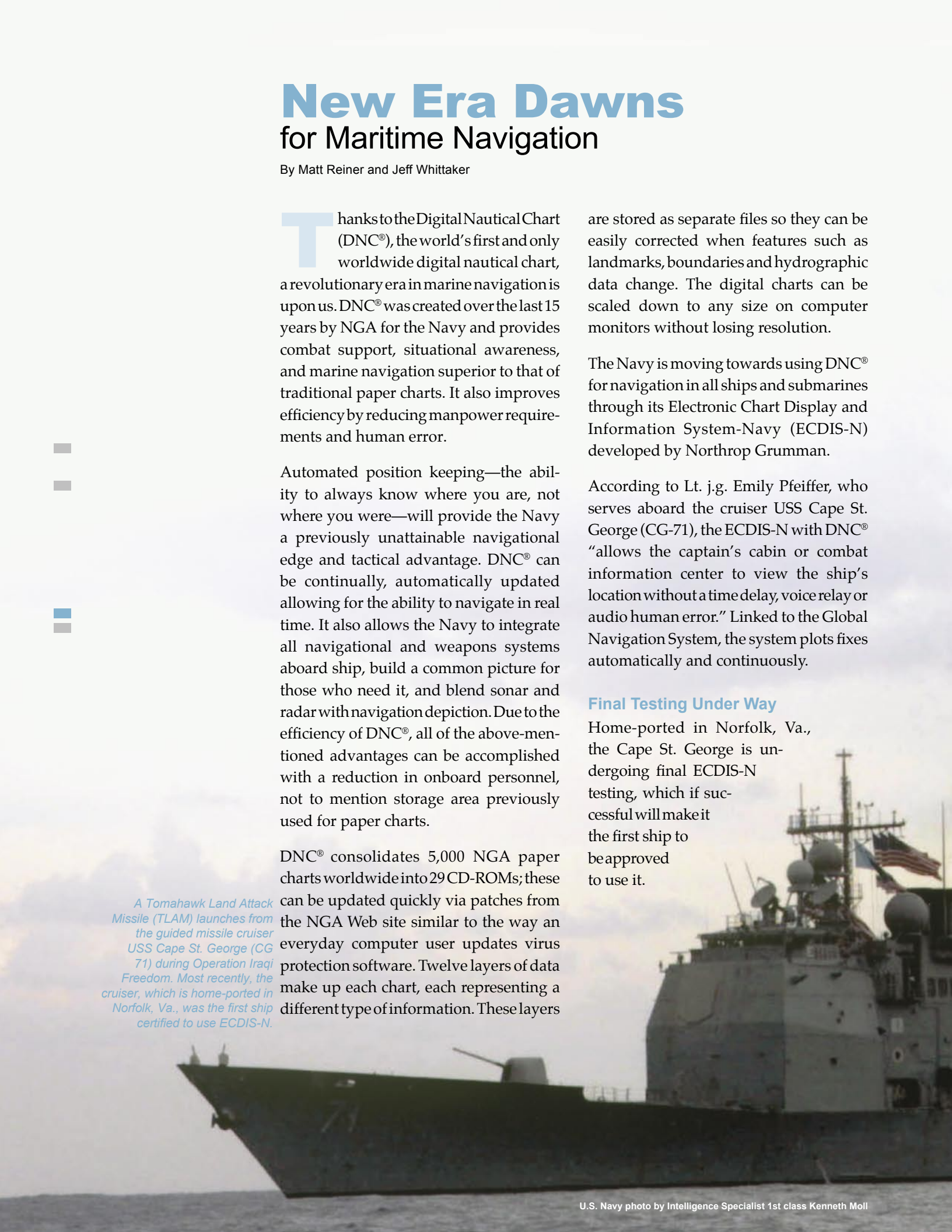
DNC® consolidates 5,000 NGA paper charts worldwide into 29 CD-ROMs; these can be updated quickly via patches from the NGA Web site similar to the way an everyday computer user updates virus protection software. Twelve layers of data make up each chart, each representing a different type of information. These layers are stored as separate files so they can be easily corrected when features such as landmarks, boundaries and hydrographic data change. The digital charts can be scaled down to any size on computer monitors without losing resolution.

The Navy is moving towards using DNC® for navigation in all ships and submarines through its Electronic Chart Display and Information System-Navy (ECDIS-N) developed by Northrop Grumman.

According to Lt. j.g. Emily Pfeiffer, who serves aboard the cruiser USS Cape St. George (CG-71), the ECDIS-N with DNC® "allows the captain's cabin or combat information center to view the ship's location without a time delay, voice relay or audio human error." Linked to the Global Navigation System, the system plots fixes automatically and continuously.

Final Testing Under Way

Home-ported in Norfolk, Va., the Cape St. George is undergoing final ECDIS-N testing, which if successful will make it the first ship to be approved to use it.



A Tomahawk Land Attack Missile (TLAM) launches from the guided missile cruiser USS Cape St. George (CG 71) during Operation Iraqi Freedom. Most recently, the cruiser, which is home-ported in Norfolk, Va., was the first ship certified to use ECDIS-N.

U.S. Navy photo by Intelligence Specialist 1st class Kenneth Moll

Sea trials for the St. George took place in May 2004 when the cruiser figuratively ventured into uncharted waters, placing the ECDIS-N into "external mode." By using DNC® in conjunction with the ECDIS-N, the navigator and helmsman could steer the ship much closer to the planned route than they could navigating with paper charts. "External mode usually keeps the ship on track within 5 to 10 yards," said St. George Quartermaster 2nd Class Dominic Genger.

That is not to say that the Navy has not been using DNC® elsewhere. Sailors can use DNC® for situational awareness in several systems, which have provided Navy personnel exposure to electronic navigation concepts and DNC®. The response has been overwhelmingly positive.

Captain Zdenka Willis, Deputy Navigator of the Navy, believes that the use of DNC is as revolutionary as "going from sails to steam." Well over 90 percent of the troops, equipment and supplies supporting Operation Iraqi Freedom arrived safely by ships using paper nautical charts for navigation and DNC® for situational awareness.

Navy submarines are also being outfitted with ECDIS-N capability. The Commander, Operational Test and Evaluation Force, recently recommended that the system be installed on the USS Oklahoma City (SSN 723), a nuclear-powered attack submarine. With approval by the Chief of Navy Operations, the first operational use of the ECDIS-N with DNC® will take place this summer, after the crew is certified to use the system. For surface ships the ECDIS-N capability is being delivered under a program called Integrated Ship Controls.

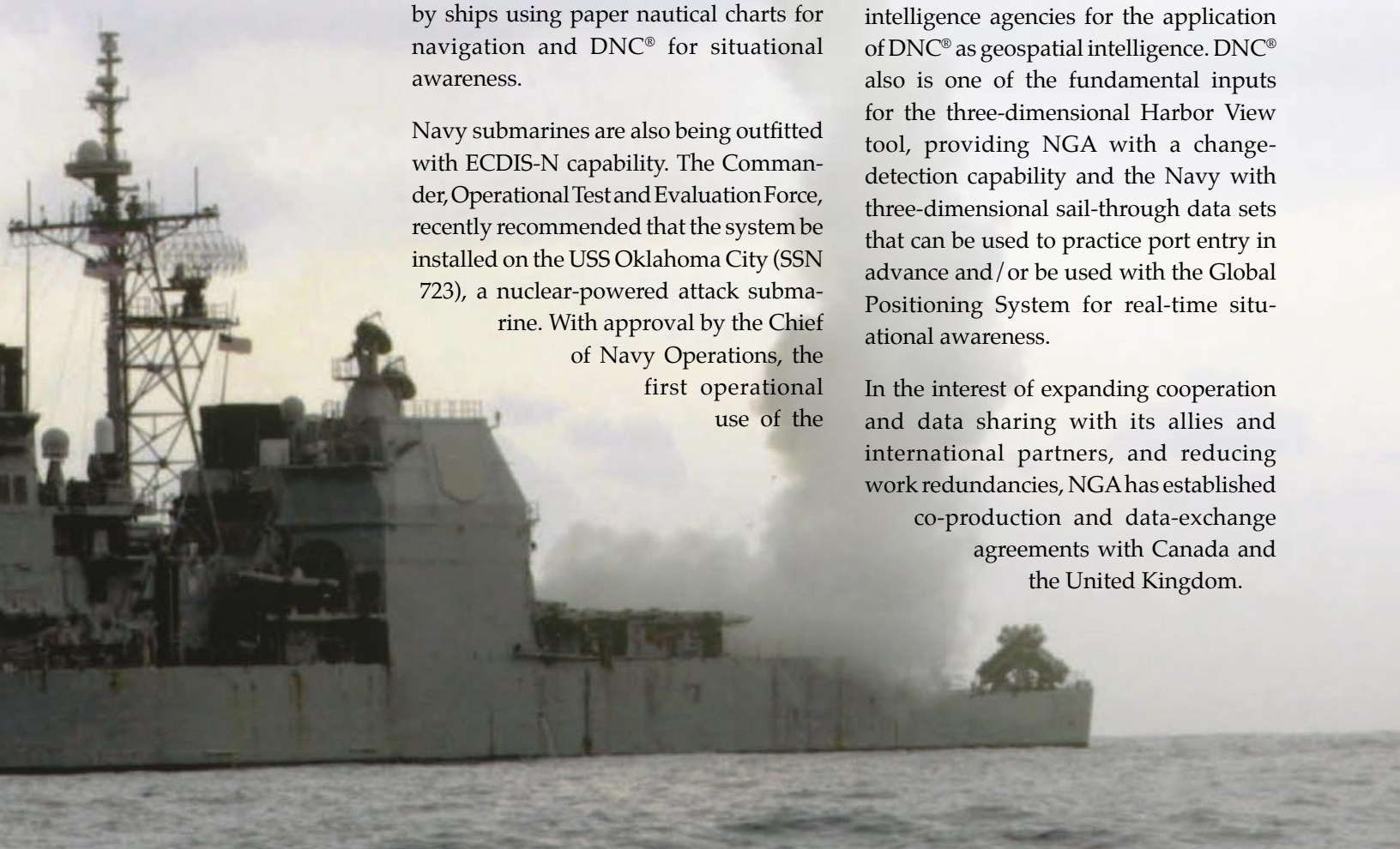
Besides the Navy, DNC® is designed to support electronic chart display systems of the Coast Guard, government agencies and government- and military-sponsored contractors. Public sale of DNC® in U.S. waters is anticipated in the near future.

Maritime Intelligence

DNC®—through its utility as a unique digital data set—is progressively assuming prominence as an element of maritime intelligence.

Cooperative work within NGA—particularly between the Americas' Region and NGA Support Team for the Transportation Command (TRANSCOM)—is providing improvements for homeland defense and port-protection graphics. NGA has developed its first interfaces with U.S. intelligence agencies for the application of DNC® as geospatial intelligence. DNC® also is one of the fundamental inputs for the three-dimensional Harbor View tool, providing NGA with a change-detection capability and the Navy with three-dimensional sail-through data sets that can be used to practice port entry in advance and/or be used with the Global Positioning System for real-time situational awareness.

In the interest of expanding cooperation and data sharing with its allies and international partners, and reducing work redundancies, NGA has established co-production and data-exchange agreements with Canada and the United Kingdom.



Canada actively maintains DNC® of Canadian home waters in the Pacific Northwest and provides NGA with digital print files of all its new-edition hardcopy charts. The United Kingdom Hydrographic Office is sharing its Admiralty Raster Chart data for incorporation into DNC® as well as providing print files for hardcopy charts. NGA is working a number of bilateral agreements with other countries for similar exchanges.

Additionally, NGA is expanding its data acquisition capability, capitalizing on the Agency's long history of cooperation with domestic and foreign hydrographic offices and by exploring other digital formats. By finding ways to automatically incorporate foreign notices to mariners, imagery, and other electronic sources, NGA can maintain DNC® at a current and accurate level to ensure that it can meet emerging customer requirements.

Other areas in which NGA is looking to exploit the DNC® concept are:

- planning and execution of strategic and tactical military operations
- application of sensory, reconnaissance and persistent surveillance technologies
- development of a more intelligently robust digital information needed by the Joint Forces for immediate and future mission planning and operation execution in littoral (coastal) zones.

The ability to navigated in real time using DNC® offers mariners unprecedented advantage. The Navy will be able to exploit this technology to better protect the homeland and ensure the seas are safe for travel. As NGA leans forward through its transformation initiatives, a common motivating force runs through the organization that unifies its mission, people and customers—maritime safety and national security.

U.S. Navy photo by Photographer's Mate 3rd Class Milosz Reterski

A course is charted on a traditional paper chart aboard the USS Enterprise (CV 65). DNC makes this process much easier through automated position keeping.

Toolkit Promotes Net-Centric Solutions for All

By Susan Marchant

NGA is pioneering a geospatial visualization tool that has far-reaching military applications. At the same time, the software package promises benefits for everyone who uses a geographic information system.

The new Commercial Joint Mapping Toolkit (CJMTK) distributes geospatial intelligence (GEOINT) over the Internet, empowering warfighters and homeland security forces with timely and relevant information to respond quickly in a crisis. With the software embedded in mission applications, users can now reach back to NGA for geospatial data and services through a common portal. Access is through Network-Centric Enterprise Services of the Defense Information Systems Agency.

With its common platform, software tools and processes, CJMTK also provides a common view that enables end-to-end collaboration, from national leaders to tactical forces on the scene. Warfighters across the Global Command and Control System have actionable intelligence where and when they need it.

CJMTK has the potential to provide wireless access to NGA products and services, allowing users to download positional information based on the geographic coordinates of their location. Ground forces, for example, could use a secure, hand-held device to set up a geo-protection cylinder that triggers warnings when friends or foes enter a 5-kilometer perimeter with a 30,000-foot ceiling.

In another example, an NGA analyst could use the toolkit to advise tactical forces regarding the location of a terrorist cell, based on imagery transmitted from an unmanned aerial vehicle. By analyzing the surrounding terrain—lines of sight or weight capacity of bridges, for example, and current variables, such as the weather—the analyst could provide options for attack by land, sea or air.

Northrop Grumman Information Technology (TASC) is NGA's prime contractor for the CJMTK. The toolkit's primary component is the software platform ArcGIS created by Environmental Systems Research Institute (ESRI) of Redlands, Calif. Analytical Graphics Inc. (AGI) of Philadelphia and Leica Geosystems AG of Switzerland also helped develop the toolkit.

Built to industry standards, the CJMTK has a single, scalable open architecture with open development environments. Development costs are borne mainly by the vendors. Regular upgrades, extended functionality and training are part of the toolkit.

Spin-Off for Industry

NGA's acquisition of the CJMTK led to the development of a new product for ESRI. To satisfy NGA's requirements, ESRI refocused its development efforts on creating an online geographic information system (GIS). These efforts led to the commercial release of its new Internet-friendly ArcGIS Engine. Thus the CJMTK procurement produced dividends for a much greater community beyond the Department of Defense through the expanded commercial offerings now available to all users who need GIS capabilities embedded in a broad range of applications.

CJMTK is available to global users through three major licensing options:

CJMTK provides warfighters with actionable intelligence when and where they need it.

The first option is centrally funded by NGA and provides *free* access to CJMTK for the command, control and intelligence community (C2I) under the Defense Information Systems Agency's Common Operating Environment and Network-Centric Enterprise Services.

The second licensing option, the Extended User Community (EUC) license, is available to users who do not qualify as members of the C2I community but want to be interoperable with the CJMTK community. EUC members obtain ESRI, AGI, and Leica Geosystems components "out-of-the-box" at their expense. The Extended User Community might include state and local authorities as well as federal organizations, such as environmental, research and architecture support groups, that do not belong to the C2I community.

The third licensing option is for Foreign Military Sales. Foreign governments may obtain CJMTK by working through a U.S. government sponsor and purchasing seats through a Foreign Military Sales office.

Solutions for C2I and Beyond

There continues to be considerable overseas interest in the CJMTK program. In January the CJMTK Program Manager Susan Riley briefed an overview of CJMTK at the Inaugural European Defense Geospatial Intelligence (DGI) Conference in London. More recently, the CJMTK Program Office met with members of the United Kingdom's Ministry of Defence (MOD). The UK MOD, like many others, is interested in CJMTK's architecture and net-centric capability.

"Our toolkit is the future of GEOINT solutions for the C2I community," Riley says. The CJMTK and its ArcGIS commercial components are available worldwide with great potential for enabling interoperability throughout the Defense Department and with its domestic and foreign partners.

At the same time, civil applications are leveraging the research and development done for the CJMTK, which has been rolled into the commercial ESRI product and its interfaces.

As stated by former Deputy Secretary of Defense Paul Wolfowitz, now president of the World Bank, the United States must "leverage information technology and innovative network-centric concepts of operations to develop increasingly capable joint forces. Our ability to leverage the power of information and networks will be key to our success."

CJMTK is a success story in the making; keep your eye on this important NGA program.

NGA Initiative Makes GPS More Accurate than Ever

By Thomas Creel

NGA is championing accuracy improvements in the Navstar Global Positioning System (GPS) that will enhance the value of the system for both military and civilian users. Managed by the Air Force Space Command for the Department of Defense, the GPS is the most exploited space-based asset that the U.S. government has ever developed. The system provides space-based radio navigation for anyone possessing a GPS receiver, available commercially in a variety of models.

The accuracy of GPS signals has improved steadily since 1990, thanks to the contributions of NGA and others. GPS signals have been the same for civilians and military since 2000 when the degradation of military signals for civilian use was suspended.

In the current effort, scheduled for implementation this spring, NGA is doubling the volume of observation data it provides from the Agency's global network of unmanned ground monitoring stations. The project is known as the Legacy Accuracy Improvement Initiative.

"Civilian and military customers have made GPS the single most exploited space-based asset that the U.S. government has ever developed."

The Air Force is combining the additional NGA data with data from its own network of ground stations to improve estimates of GPS satellite positions and velocities. For customers, these efforts will translate into more accurate GPS navigation signals. NGA's initiative will also improve the integrity of GPS signals: With the increase in monitoring, controllers will be able to respond more rapidly when a satellite experiences technical problems.

The military uses the GPS for everything from emergency rescue to enabling the guidance package in precision weapon systems. NGA customers will see improvements in targeting and other special products as a result of the initiative.

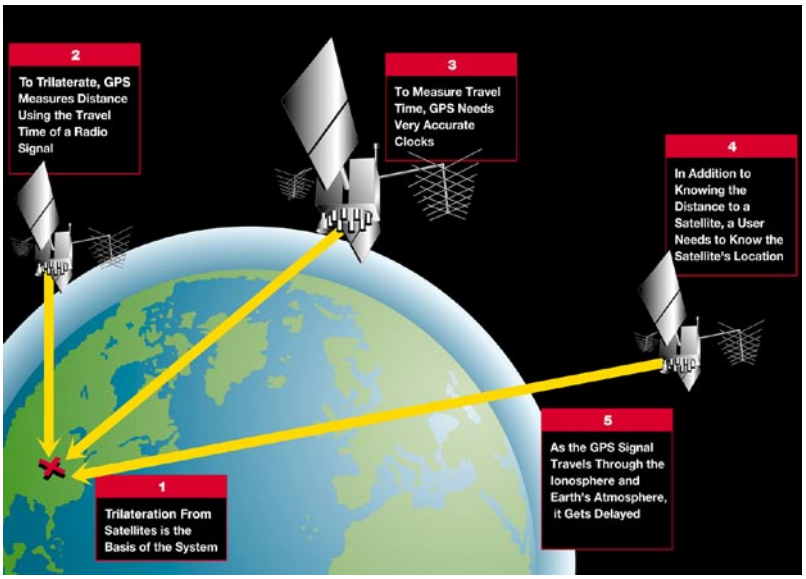
Civilian uses of GPS range from recreation to cell-phone operation. Global shipping, oil exploration and wildlife management are but a few of the system's many specialized civilian applications.

Next year, NGA will complete a project that's been under way for several years to upgrade its ground tracking stations with new receivers that meet enhanced security requirements. To better thwart the spoofing of GPS signals, the new receivers have greater capability to validate and decrypt the signals. They also provide additional capability that enables the Department of Defense to better control the quality and availability of signals.

Reference Information

NGA provides a global coordinate frame and global orbit data that are critical to the success of the GPS. Without this global reference information, users would not be able to synchronize their location on Earth with the locations of GPS satellites in space.

Known as World Geodetic System 1984, the global coordinate frame is a mathematical representation of the Earth's shape. This three-dimensional coordinate system also contains a gravity model used for orbit computations. As another input for orbit computations, NGA provides data (Earth Orientation Parameters) each



The accuracy of the Global Positioning System depends on data NGA provides to the Department of Defense on the orbit of each satellite in the constellation.

week that predicts changes in the speed and axis of the Earth's rotation. This data is derived in collaboration with the U.S. Naval Observatory.

Information on NGA's reference frame is stored within all GPS user equipment. Receivers combine the parameter- and reference-frame data input via the GPS satellite signals with the stored reference information to calculate positions on Earth. Some GPS receivers store a reference magnetic model that gives the angle between true and magnetic north when using the receiver with an internal or external magnetic compass. Nearly every GPS receiver includes transformation parameters that enable users to move from World Geodetic System 1984 to other systems, including regional coordinate systems.

Does NGA make a difference in everyday life? GPS users—warfighters, scientists, pilots, firefighters, drivers, sports people and you name them—depend on information NGA provides to keep the system up and running. At the same time, NGA continues to improve this customer support by enabling enhanced signal integrity and accuracy.

How GPS Works

The Global Positioning System is the only fully operational system able to show users their exact position on or above the Earth anytime, in any weather, anywhere. The GPS constellation of 28 satellites broadcasts positional data from orbits 11,000 nautical miles above the Earth's surface.

Radio signals broadcast by GPS satellites give a satellite's time and location. The receiver automatically subtracts the difference between the time the signal was sent and when it was received to calculate the satellite's distance based on the formula "distance = time x speed." (Speed is a constant 186,000 miles per second, the speed of light.) The GPS receiver provides an accurate position and time by automatically measuring the distances to at least four satellites. Four satellites are needed to very accurately synchronize the receiver's clock with the satellite clocks to compute distances. Using more satellites improves the accuracy of the computed position and time.

NGA Provides Key Information in Tsunami Relief Effort

By Michelle Herman

Within hours of last December's tsunami NGA provided key information to relief workers about lives at risk and the location and extent of the damage.

Analysts tasked new imagery and gathered existing imagery and geospatial products over the 12-country area struck by the tsunami almost immediately. The pre-tsunami imagery allowed for "before and after" analyses and precise determination of the damage.

Forty-eight hours later, NGA began providing daily geospatial intelligence (GEOINT)—imagery-derived assessments for the U.S. Agency for International Development's Office of Foreign Disaster Assistance (OFDA). This group is the U.S. government's focal point for official disaster assistance and a conduit for information to and from international relief agencies. As the American response expanded, NGA provided products to the U.S. Pacific Command and other U.S. government agencies. NGA also coordinated with international partners on the release of products for the international relief effort.

Information NGA provided on the extent of the tsunami's inland penetration allowed for estimates of the total affected population and was used to choose priority areas for the distribution of life-saving supplies and personnel. The status of major transportation infrastructure was also noted in the damage assessments. Damaged roads, collapsed bridges and areas of standing water could have prevented access to affected populations.

To create a practical product that could be used in the field, NGA analysts combined damage information with a digital map and/or commercial imagery base. As more information became available, the

This panchromatic image taken two days after the tsunami struck shows catastrophic damage to a village near Banda Aceh. The tsunami has swept away homes, leaving only debris and flooded areas.

Three-dimensional simulations show the water level in Banda Aceh, Indonesia, at sea level (top) and at the recorded height of 45 feet above the normal sea level on Dec. 28. The author draped the Digital Globe imagery over elevation data to create the views.

On the first day of a new year, we join the world in feeling enormous sadness over a great human tragedy...The carnage is of a scale that defies comprehension.

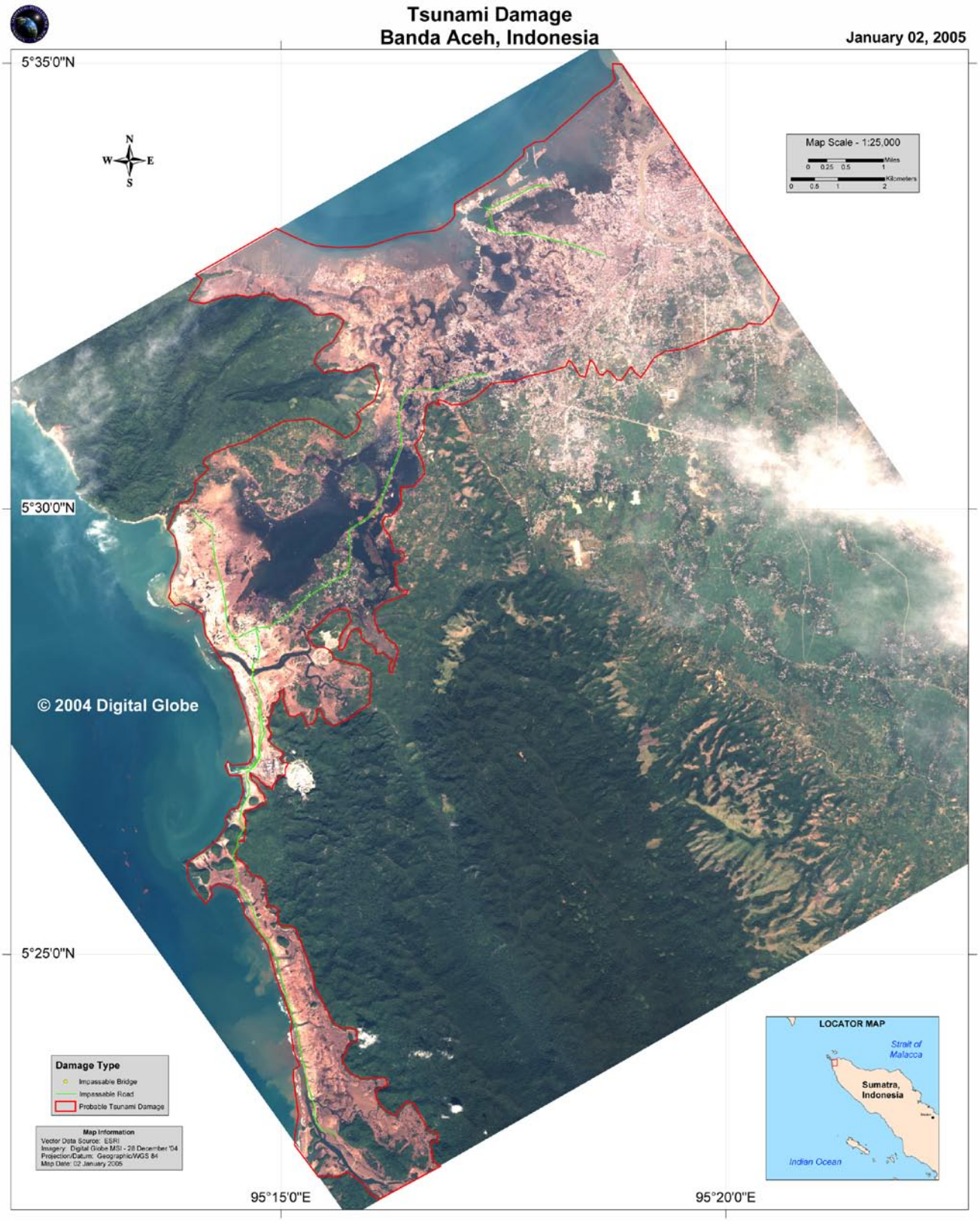
—President George W. Bush

analysts updated their assessments and transmitted the information electronically to NGA customers.

For some of the hardest-hit areas, such as Banda Aceh, Indonesia, the analysts wrote damage reports and created additional graphics based on commercial imagery to supplement the damage-assessment maps. The reports gave breakdowns of the damage to residential, cultural and economic structures. These products were particularly important for situational awareness and were tailored more to policymakers and U.S. government officials.

Like the Darfur population displacement graphics used in Congressional hearings or the three-dimensional walk-throughs used in securing last summer's Olympics, the products NGA provided for tsunami relief were lifesavers. Along with the expertise and services that went with them, these products show the power of GEOINT, as it continues to make a difference in the lives of people around the globe.

(See related article on NGA's response to the tsunami in the March-April Pathfinder.)



A coded graphic of Banda Aceh provided to relief workers shows the damage area outlined in red, impassable roads marked in green and yellow circles over washed out bridges.

NGA HELPS

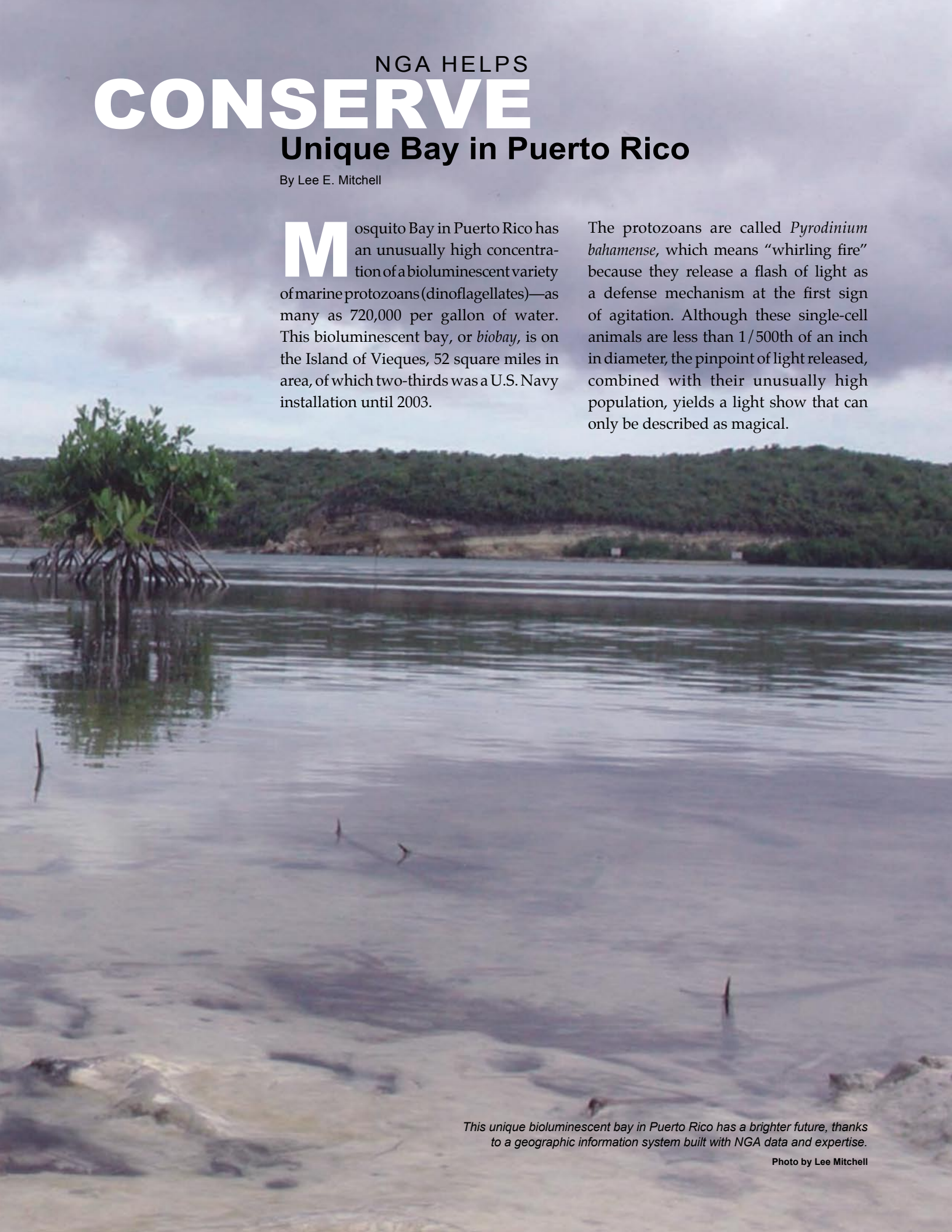
CONSERVE

Unique Bay in Puerto Rico

By Lee E. Mitchell

Mosquito Bay in Puerto Rico has an unusually high concentration of a bioluminescent variety of marine protozoans (dinoflagellates)—as many as 720,000 per gallon of water. This bioluminescent bay, or *biobay*, is on the Island of Vieques, 52 square miles in area, of which two-thirds was a U.S. Navy installation until 2003.

The protozoans are called *Pyrodinium bahamense*, which means "whirling fire" because they release a flash of light as a defense mechanism at the first sign of agitation. Although these single-cell animals are less than 1/500th of an inch in diameter, the pinpoint of light released, combined with their unusually high population, yields a light show that can only be described as magical.



This unique bioluminescent bay in Puerto Rico has a brighter future, thanks to a geographic information system built with NGA data and expertise.

Photo by Lee Mitchell

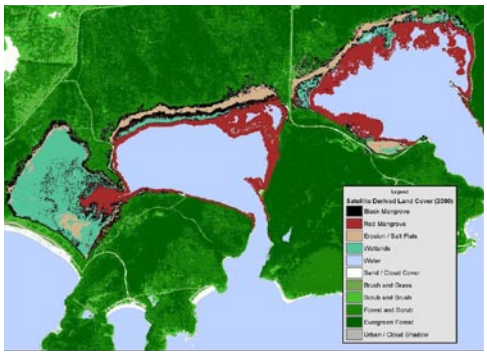
With help from a local biologist, Lee Mitchell gathers depth readings of the biobay.

Intrigued by the biobay and concerned about its future, the writer approached NGA management with a proposal to build a geographic information system (GIS) to assist in the bay's preservation. The goal was to use skills acquired as a geospatial analyst to develop information conservationists could use to understand and protect the bay. Special consideration was given to ensure that the data and information generated would be releasable to all and made available at no cost to NGA. The writer was given a specific amount of work time to develop the GIS but also spent many personal hours and weekends on it. Working closely with NGA headquarters, the U.S. Navy and other information providers, the writer obtained the appropriate permissions to generate and distribute a unique Biobay GIS.

Organizations such as the U.S. Fish and Wildlife Service, Puerto Rico Department of Natural Resources (DRNA), Biobay Conservation Group and Vieques Conservation and Historical Trust are intent on ensuring the bay's long-term health, and their leaders quickly embraced the effort.

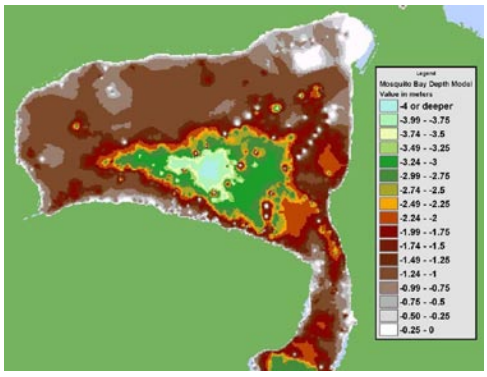
Along with training on how to use map viewing and printing applications, conservationists received:

- Multiple copies of the finished Biobay GIS CD and a software installation disk
- Hardcopy map plots of the larger map sheets included in the GIS
- Delivery of the product to the Biobay Conservation Group (www.biobay.



Ikonos multispectral imagery was used to generate a map of vegetation in the biobay system, including Mosquito Bay on the left.

Data from the NGA-NASA Shuttle Radar Topographic mission was used to generate a map of the biobay watershed.



A model created from survey readings shows bottom depths in Mosquito Bay.

org), Vieques Conservation and Historical Trust (www.vcht.org), DRNA and U.S. Fish and Wildlife Service in August 2003

- Loading of the GIS in the Historical Trust's computer lab—accessible and free to the general public.

Building the GIS

After several consultations with NGA officials to discuss how geospatial intelligence (GEOINT) could help protect the biobay, the Agency released two key data sources. The first was a March 2000 Ikonos multi-spectral commercial imagery collection. The second was 30-meter resolution elevation data collected for NGA on the February 2000 Shuttle Radar Topography Mission (SRTM).

The Department of Earth and Environmental Sciences at Wesleyan University in Connecticut also provided a dense hydrographic survey of Mosquito Bay produced by a team of graduate students in 2003. Other data sources were obtained from the Navy, U.S. Geological Survey and National Oceanic and Atmospheric Administration.

After gathering the necessary foundation data, the writer:

Conducted a field survey. With the help of local conservationists and a hand-held Global Positioning System (GPS) receiver, ground truth was obtained in key areas surrounding the bay to assist in geospatial analysis.

Generated a depth model. Bathymetry collected during the field survey was added to depths collected by the Wesleyan students to generate a 5-meter resolution digital bottom model of the bay. Analysis of the depth model revealed a previously unknown shallow sandbar within the neck of the bay.

Measured a three-dimensional model. Virtual GIS techniques were used to measure the size and volume of the bay and determine that it encompasses some 212 acres filled with over 317 million gallons of water.

Classified the land cover. GPS measurements of mangroves and other vegetation types were used, along with the multispectral imagery, to classify the vegetation around the bay at a resolution of 4 meters. Because healthy mangroves and other plant types play an important role in keeping the biobay alive, this detailed layer provides necessary information about flora for land-management planning.

Generated terrain layers. The SRTM terrain model was used to generate multiple data layers, including a watershed layer that shows the geographic extent of all the land area that drains into the biobay. The watershed layer provides a basis for understanding areas where land clearing and erosion could lead to excessive sediment runoff—a scenario that could disrupt the delicate balance of the biobay.

Created a view-shed layer. A line-of-sight layer was created that provides information on terrain that can be seen from any point within the biobay. This view-shed layer provides information to urban planners and reserve managers on how to avoid and/or remove light pollution from within the biobay viewing area.

Applications of Biobay GIS

The Biobay GIS provides conservationists improved visualization and analysis tools.

Map files derived from the GIS software suite allow the user to identify, find and/or measure individual layer types; interactively display different layers; zoom and rescale; pan/roam around the geographic extent; and print custom-produced maps. The Biobay GIS contains 25 layers of data. An interactive legend updates itself as these various layers of raster and vector data are activated. An overview map of Vieques displays the current area of interest for reference and updates as the user changes scale or location. An interactive scale bar shows distance in miles, nautical miles and kilometers, and adjusts according to changes in scale.

The Puerto Rico Department of Natural Resources is using the Biobay GIS to update its land-management plan for Vieques. Yale University and the Nature Conservancy have each requested and received copies of the GIS, which will help them in their independent environmental studies on Vieques.

The Biobay GIS can help conservationists understand factors such as terrain, watershed, land cover and the habitats of the bioluminescent protozoan and other organisms living in the bay, as well as their proximity to existing or proposed urban developments.

NGA also "gained a lot" from this project, according to one of the Agency's senior managers:

"The Biobay project advances our geospatial analysis of littoral areas, as well as our understanding of the ecological sensitivities that may be involved in any area of strategic importance," he said.

Hopefully, such understanding will help protect and preserve the beautiful and unique organisms that grace the bioluminescent bay of Vieques. It is an incredible experience to kayak or swim in the bay while millions of pinpoints of light flash around as you disturb the water. For the 9,000 residents of Vieques and the visitors who are sure to come, this experience hopefully will be repeated many times in the years ahead.

Our Heritage

Above the Earth to Know the Earth

By Martin Gordon

The military began using technology to learn what was out there, what the enemy was doing, as soon as the means to do so became available.

The French brothers Jacques Etienne and Joseph Michel Montgolfier launched the first successful balloon ascension June 5, 1783, using three animals as passengers. The first manned flight followed that October. Both British and French thinkers immediately saw the military value of being able to send military and naval forces above the Earth. Their suggested applications included reconnaissance, map making, bombing, and day and night communications.

The oldest surviving balloon photograph was a view of Boston made in October 1860 by Samuel King and J.W. Black. King's account of making the photograph was published in the Boston Herald on Oct. 16, 1860.

America's use of this new technology began in the Civil War when Thaddeus Lowe and at least six other civilian balloon operators offered their services to the United States. Lowe gained the support of the Army of the Potomac's commanding general, George B. McClellan, who saw the value of balloon-based reconnaissance. First in civilian balloons and later in sturdier military balloons, Lowe rapidly demonstrated the balloon's value. With an accompanying military telegrapher, Lowe on June 18, 1861 sent President Abraham Lincoln the first report of aerial observations, proving that nearly instantaneous reporting was possible. The Army put Lowe to work the following week observing and reporting on Confederate forces operating in Northern Virginia.

The first successful balloon photograph was a view of Boston made in October 1860.

Other balloon reconnaissance efforts failed for want of the proper technology, inadequate ground support, or the open opposition of most of the Army officers involved. As one captain replied, when told to help the balloon effort, "I did not join the Army to be a bird." Wanting more precise and reliable reconnaissance than the civilian balloonists were providing, the Army ignored such complaints and started sending officers up. One was George Armstrong Custer, who overcame his fear of ascending in balloon baskets that appeared too light in weight to support him. Custer soon recommended night flights in order to better observe enemy encampments. Night fires made it easier to see the distribution of Confederate forces through the trees around them. This change paid off, as morning mess fires they lit just before dawn clearly signaled their strength and distribution. Coincidentally flying at night made Custer a harder target for Confederate gunners.

Ballooning did not last the war, however. A blend of technological and staffing problems combined with military skepticism and bureaucracy to end this use of balloons by June 1863.

Industry

Why Certification Matters to NGA

By Monroe Ratchford

An office full of heroes. They got the job done and worked long hours to do it. But clearly there was a better, more efficient way to do things."

That's how a consultant described NGA's Enterprise Operations Directorate (E) prior to its certification by the International Standards Organization (ISO).

In the words of Enterprise Operations Director Dr. Robert H. Laurine Jr., "To support the transformation of NGA, our enterprise operations must exhibit the discipline and effectiveness of 'best in class' businesses."

"ISO certification is the cornerstone for building NGA's future."

—Robert Laurine

Cornerstone of Future Enterprise

ISO certification of NGA enterprise operations—a first for the Intelligence Community—means that NGA has in fact achieved a transformation of its these operations.

"ISO certification is the cornerstone for building NGA's future. With ISO certification, we have defined our process-management structure," Laurine said. "ISO processes provide a customer/mission-focused approach to enterprise operations."

NGA chose the ISO's 9000 Quality Management System to be the framework for its management process. The ISO 9000 series international standard is a generic set of management controls and is a widely accepted international standard for high-quality management systems.

With the transformation of NGA, the need for reliable, repeatable execution of information- technology tasks and high availability of NGA systems to support NGA's mission was critical. The key to meeting customer requirements and reducing variability was replacing an ad-hoc operational environment with a process-based structure that was also more efficient and effective.

Analysts and Customers Benefit

ISO 9000 provides the foundation for meeting the needs of NGA analysts and customers and the infrastructure to facilitate the convergence of system architecture.

With ISO 9000, analysts get a consistent, disciplined process that will drive networks, data centers, libraries, applications, etc., to higher levels of performance and availability. The system is designed to ensure that the right information is

available to solve the hardest geospatial intelligence (GEOINT) problems and that time is available for analysts to anticipate, discover, analyze, predict, evaluate courses of action and make recommendations. With its preventive approach, ISO 9000 provides an information-technology infrastructure that is self-sustaining, self-protecting, self-reporting, self-healing and self-optimizing.

ISO 9000 not only ensures that systems are available and reliable but that the right products and information get to the intended customer when they are needed. The system incorporates GEOINT fusion concepts in source management, Intelligence Preparation of the Environment methodology for analysis, and access for end-users through self-service portals.

ISO 9000 improves the efficiency of current architecture while helping NGA achieve its vision of convergence by providing for a robust reliable infrastructure across multiple security domains. Its "best in industry" process design includes internal audits to push compliance and metrics to measure performance of the infrastructure in meeting customer needs and requirements.

ISO Certification

The International Organization for Standardization (ISO) is a non-governmental organization, based in Geneva, Switzerland, that links national standards institutes in 148 countries. ISO 9000 certification ensures that an organization has the ability to create a required product or service from appropriate inputs in a systematic, repeatable way. Adopted by the business community more than 15 years ago, standards like those of the ISO 9000 system are now increasingly being required of government agencies.

 Continued from page 7

IPE involves more than just a re-characterization, or "renaming," of analytic steps. IPE is a systematic integration of procedures to enhance synchronization of activities and resources throughout the organization. Use of IPE will provide greater insights into efficacy of operations—what data sets are useful in solving what problems, what software and hardware "breaks" in working what problems, etc.—that will allow management to better prepare for future crises. By strengthening our own commitment to IPE, NGA is playing a decisive role in performing this "fresh thinking " that the DNI has rightly asked from us all.

James R. Clapper, Jr.
Lieutenant General, USAF (Ret.)
Director

DNI Visits NGA

On May 2, Director of National Intelligence (DNI) Ambassador John Negroponte and Deputy Director Air Force Lt. Gen. Michael V. Hayden, addressed the NGA work force and challenged NGA, along with the larger Intelligence Community, to use "fresh thinking" when handling intelligence problems. His point: although intelligence is "not a panacea" for the diversity of threats the United States faces in the 21st century, employees must raise their performance levels on intelligence issues to meet our nation's challenges in the new century. NGA was the first intelligence agency to be visited by the newly appointed DNI.

Photo by Larry Franklin

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

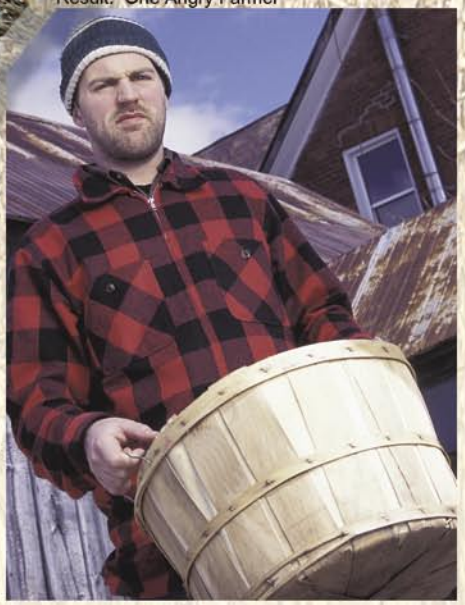
GEOINT

It Makes the Difference

Desired Destination: Cape City Airport

Actual Landing Area: Farmer Brown's Field

Result: One Angry Farmer



Lost Travelers

GEOINT: Get to your destination on time, all the time.

WWW.NGA.MIL

WWW.NGA.MIL