

THE NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

Vol. 6 No. 6

PATHFINDER

THE GEOSPATIAL INTELLIGENCE MAGAZINE

SERVING THE FRONT LINE

November/December 2008



Foundation Data and Technology

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE DEC 2008		2. REPORT TYPE		3. DATES COVERED 00-11-2008 to 00-12-2008	
4. TITLE AND SUBTITLE Foundation Data and Technology (Pathfinder, November/December 2008)				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Geospatial-Intelligence Agency, Office of Corporate Communications, 4600 Sangamore Road, Bethesda, MD, 20816-5003				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 28	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



ON MY MIND

Maintaining the Technical Advantage

In offices, labs and forward-operating bases, talented members of the NGA team are developing innovative and effective ways to produce the highest-quality geospatial intelligence (GEOINT) necessary for the problem at hand. Technology is often given credit for revolutionizing a process, but the real credit goes to the people behind the technology. They innovate, build and operate the tools and techniques to give our warfighters and policymakers the information they need to do their jobs. But there are many factors that influence how NGA approaches technology development.

Asymmetric threats, adversarial nations and rapidly expanding technologies require NGA to adapt and think systematically about what we are doing now, what we should be doing and how we will do so in the future. In the recently released *Vision 2015: A Globally Networked and Integrated Intelligence Enterprise*, the Director of National Intelligence reiterates our need for multiple, integrated collection systems, for integrated processing, exploitation and dissemination architecture, and for collaborative analysis. The key design principles of *Vision 2015* are adaptability, alignment and agility; these principles are guiding NGA's technology priorities. Incorporating multiple sensors into our architecture and analysis and improving exploitation tools and techniques are two examples of how technology is improving our operations.

Sensor Advantages

Over the last several years, combat operations have demonstrated what full motion video (FMV) brings to the fight. As airborne reconnaissance advances, wide-area surveillance (WAS) enables a better view of the battlefield and multiplies the effectiveness of each mission. The added value that airborne imagery brings to a large number of missions and operations reinforces our need to fully support intelligence, surveillance and reconnaissance (ISR) efforts.

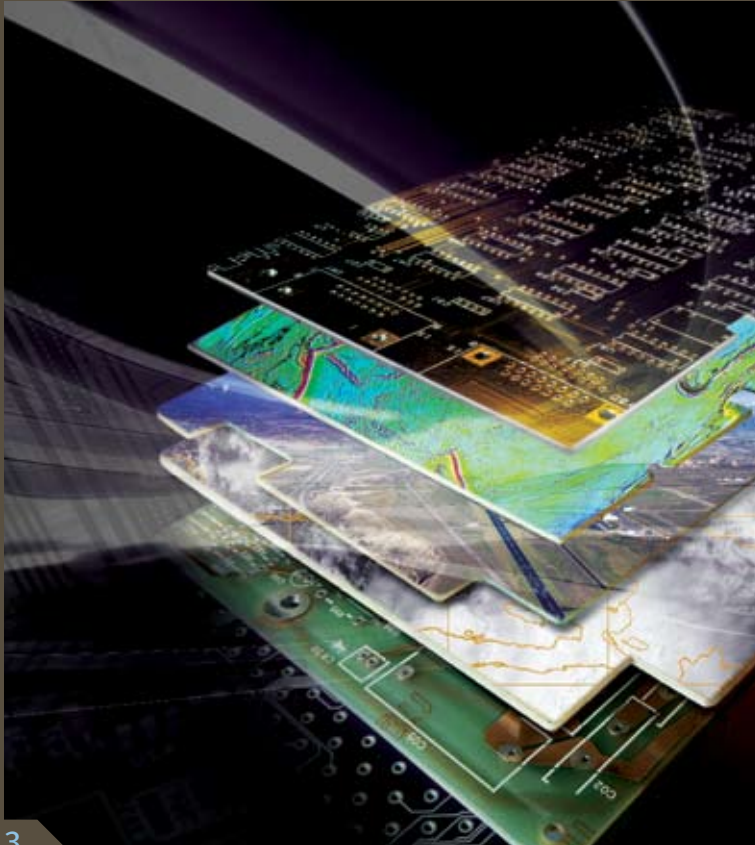
Additionally, NGA and our mission partners are leveraging existing capabilities and adapting them to new applications. Hyperspectral imagery, light detection and ranging (LIDAR) and advanced radar applications are providing high-resolution terrain information that promises feature detection, extraction and attribution. In Afghanistan, we have seen firsthand the impact of these new applications in a collaborative coalition effort. NGA and numerous partners used hyperspectral imagery to gain a better understanding of the terrain of Afghanistan, creating foundation data that assisted in a variety of mission sets. These valuable, dynamic capabilities produce exponentially more data that require significant storage and exploitation space and appropriate extraction tools that make sure it is used effectively.

Exploitation Advances

Improving our sources and fusing national technical means (NTM) with commercial and airborne assets adds significant value to our capabilities. Still, our real power resides in our ability to perform geospatial analysis and work with our U.S. and allied counterparts. Our analysts require tools that enable them to discover, exploit and share existing imagery and data. Tools like Consolidated Analytic Spatial initiative (CASI) and GEOINT Online (GO) allow for quick retrieval of vast quantities of data in a user-friendly format. NGA is looking outward for other tools to aid in exploitation, like SOCET GXP®, Adobe® PDF, Microsoft® Virtual Earth™, ESRI Arc Explorer™ and Google™ Earth. Our analysts continue to seek out more collaborative tools as they see the power to intuitively find the imagery and geospatial information that they need to produce accurate, relevant and timely GEOINT.

To maintain our technical advantage, NGA continues to develop a diverse array of GEOINT sources, tools and techniques. Technology has played a major role at NGA and will continue to do so, particularly as we focus outward and work more closely with Defense and Intelligence Community partners every day. And at the end of the day, we must all remember that our people drive our analysis, innovation, creativity and progress.

Robert B. Murrett
ROBERT B. MURRETT
Vice Admiral, USN
Director



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ON THE COVER

NGA broke ground for its New Campus East (NCE) on Sept. 25, 2007. As the new home for geospatial intelligence (GEOINT), NCE promises to foster an improved environment for the ongoing fulfillment of NGA's mission. The NGA Director, Navy Vice Adm. Robert B. Murrett, recently toured the NCE construction site at Ft. Belvoir, Va., with the Under Secretary of Defense for Intelligence, retired Air Force Lt. Gen. James R. Clapper Jr., Murrett's predecessor. The two surveyed the work in progress, admiring the solid foundation being laid for the future of GEOINT. That foundation includes the agency's accumulating wealth of geospatial foundation data and the technological systems used to exploit and deliver it. Agency personnel will begin the move to NCE in 2010. NCE will be completed in 2011. Photos by Larry Franklin. Photo illustration by Carmella Bender.

More to the Story?

The online Classified Pathfinder, which is accessible by members of the Intelligence Community, may include additional information and expanded sections of some Pathfinder articles. The Classified Pathfinder provides a forum for reading and discussing topics at the level of "Unclassified//For Official Use Only" or higher. For information please contact the editor, Heather Cox, at 301-227-2290.



LETTER TO OUR READERS

Foundation Data and Technology

Every building rests upon a foundation, every publication begins with a blank page and every achievement has a starting point. From concept to product, emerging ideas often evolve into successful actions.

NGA's dedication to providing timely and relevant geospatial intelligence (GEOINT) is fueled by emerging technologies founded upon the structurally sound data points of NGA's predecessor agencies. Whether as a building, an information system or a class of data, NGA's strong foundation allows the agency to succeed in fulfilling its mission and supporting its partners. This Pathfinder explores the relationship of foundation data and technology and the groundwork they lay for the agency's success.

NGA Deputy Director Lloyd Rowland reminds us of the intimate relationship between geospatial foundation data and the work of this agency. The successful launch of the GeoEye-1 satellite, a part of the NextView program, points to the continual need to develop both data and the technology to deliver it, to strengthen the momentum of GEOINT in the pursuit of the nation's security.

Technology and foundation data magnify NGA's collaboration with and responsibility to the Intelligence Community. These crucial elements also prevent threats and protect warfighters, as illustrated by NGA Director Vice Adm. Murrett's article on the importance of the Global Positioning System (GPS) to actionable GEOINT.

Wayne Schneider and Denise Damschroeder provide insight into the Boundary Technical Working Group, a critical partnership that establishes the most accurate geospatial truth related to international boundary data in mapping and geospatial history. No less valuable, urban feature data reinforces the GEOINT support NGA provides to military forces, as discussed in Gregory Wagner's article.

Valuable GEOINT is collected and constructively shared through the Consolidated Analytic Spatial initiative (CASI). John A. Duncan and Emily Kilman introduce CASI and its role in improving information sharing among analysts. Mark Munsell outlines the Office of Global Navigation's efforts to achieve the future of GEOINT by meeting increasing requirements to seamlessly manipulate data at the touch of a button.

Join NGA Historian Dr. Gary E. Weir as he travels through decades past, exploring deep into the foundational base of gathering GEOINT. Finally, Glenn Forinash shares his perspective on how the New Campus East (NCE) will enhance time-dominant operations. The building of NCE continues to progress ahead of schedule and serves as an ever-present reminder of the importance of a solid foundation to achieving success.

Success and accomplishments come in many forms. The next issue, January/February 2009, will relate many of NGA's significant accomplishments of this past year.



PATHFINDER

Published by the National Geospatial-Intelligence Agency
Office of Corporate Communications
4600 Sangamore Road, Mail Stop D-54
Bethesda, MD 20816-5003
Telephone: (301) 227-7388,
DSN 287-7388
E-mail: pathfinder@nga.mil

DIRECTOR

Vice Adm. Robert B. Murrett, U.S. Navy

DEPUTY DIRECTOR

Lloyd Rowland

OFFICE OF CORPORATE COMMUNICATIONS, DIRECTOR

Paul R. Weise

INTERNAL COMMUNICATIONS BRANCH, CHIEF

Louis J. Brune

EDITOR

Jason K. Michas

MANAGING EDITOR

Kelly M. Kemp

GRAPHIC DESIGNER

Carmella E. Bender

CONTRIBUTING AUTHORS

Denise Damschroeder

John A. Duncan

Glenn Forinash

Emily Kilman

Mark Munsell

Vice Adm. Robert B. Murrett, Director, NGA

Dr. Nikolaos K. Pavlis

Lloyd Rowland, Deputy Director, NGA

Wayne P. Schneider

Gregory Wagner

Dr. Gary E. Weir

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. For details on submitting articles, send an e-mail to pathfinder@nga.mil.

The Pathfinder is the medium with which the National Geospatial-Intelligence Agency enhances and promotes public awareness and understanding of the discipline of geospatial intelligence. The Pathfinder is an authorized Department of Defense publication for members of the Department of Defense. Contents of this publication are not necessarily the official view of, or endorsed by, the U.S. government, Department of Defense or NGA. Articles in the Pathfinder may be reproduced in whole or in part without permission, unless stated otherwise. If they are reproduced, please credit the author and the "National Geospatial-Intelligence Agency, the Pathfinder magazine." Any reproduction of graphics, photographs and imagery is subject to the original copyright.


PAUL R. WEISE

Director, Office of Corporate Communications

GUEST COLUMN

The Advance of GEOINT

BY LLOYD ROWLAND, DEPUTY DIRECTOR, NGA

More than a decade and a half ago as a pilot in Desert Storm, I sat down to plan a mission with a map on my knee board. At the time, I remember thinking I needed a fused product that would allow me to see the imagery overlay of geospatial information with up-to-date imagery intelligence. Only later did I come to realize the product was one manifestation of what we today know as geospatial intelligence (GEOINT).

Over the years I have come to admire the commitment, flexibility and can-do spirit of the employees of NGA and our predecessor agencies. Time and time again, they have demonstrated the strong desire to make sure our mission partners have the information they need when they need it, in order to make key decisions and to solve today's toughest intelligence challenges. Our people have built more than an agency. We have led the way for the emergence of the GEOINT discipline and ensured the success of the GEOINT tradecraft. With the establishment of the National Imagery and Mapping Agency (NIMA) in 1996, eight separate organizations were combined to bring together the nation's most capable imagery and geospatial assets. NIMA's creation provided a critical fusion of skills and technologies to expand the GEOINT discipline under one mission umbrella.

In 2000, we began to experiment with fusing imagery, imagery intelligence and geospatial information. This conceptual experiment gained significant momentum after Sept. 11, 2001. We were among the first to answer the call for unified intelligence operations that were at the forefront of the nation's consciousness. Today we are expanding the GEOINT footprint, pushing forward in fusing GEOINT with other intelligence disciplines and exploiting the digital environment. Our goal is to make sure policymakers, warfighters, and other end users have the GEOINT advantage. Whether our partners need a hardcopy map, a physical model, 3-D visualization or fused intelligence, NGA is there to give them the critical edge.

Looking Forward

As we move forward, GEOINT shows the way! Our future is extremely bright, thanks to our ability to meet the ever-increasing need for relevant and responsive GEOINT



Lloyd Rowland, Deputy Director, NGA

in a time of unprecedented global change. NGA and our partners learn daily through the ongoing war against violent extremism and combat operations how to cooperate, share and fuse data. NGA has a forward-deployed strategy that puts our people with our mission partners on their ground and operating on their terms. The impact of this strategy has been tremendous. As Vice Adm. Murrett and I travel the world, we receive accolades and appreciation for the difference the NGA workforce, and the relevant, timely and actionable intelligence they deliver, is making on the frontline.

That said, the GEOINT community always has room to grow and challenges to face, so we cannot rest on our laurels. We must view every challenge as an opportunity to excel and to move GEOINT into new arenas. I would like to highlight six opportunities that will move us forward.

Balancing Mission Requirements

There is the ever-present need to balance time-dominant with non-time-dominant mission requirements.



This means we must maintain a constant vigilance and reprioritize resources as needed. It also requires NGA personnel to maintain a sense of urgency, while pacing ourselves for the long haul. Remember—this is not a sprint; it is a marathon. It is entirely probable that we will be fighting the forces of violent extremism for several decades to come.

Increasing Partnerships

NGA cannot accomplish our mission alone. We need our existing partnerships, and we need new ones. We are managing more agreements and providing more data to more users than ever before. The good news—GEOINT is getting into the hands of those who need it. The bad news—many more users still need GEOINT and either do not know they need it or do not yet have the capability to get it. Spread the word!

Recruiting, Training and Retaining a World-Class Workforce

As demand for GEOINT continues to grow, NGA must keep the outstanding workforce we have and attract the best and brightest to meet future requirements. Over the next 12 months, NGA will conduct an aggressive hiring campaign to reinforce our great workforce. The insertion of new hires will undoubtedly bring new energy, new ideas and new talent to our agency and our mission. The goal is to hire the right people with the right skill sets to meet the demands of today, tomorrow and beyond.

Expand Industry and Academic Engagement


GEOINT's way ahead is grounded in our people, but it has a technological angle, too. We must continue to expand our industry and academic engagement to develop innovative solutions. We will put the best minds of government together with the brightest minds in industry and academia to solve the toughest challenges. For example, with the exponential increase in terabytes of information, one of our biggest challenges today is managing, storing and retrieving information. We need industry and academia to help us identify ways to address these challenges—and they will.

Protect Our Research and Development Investment

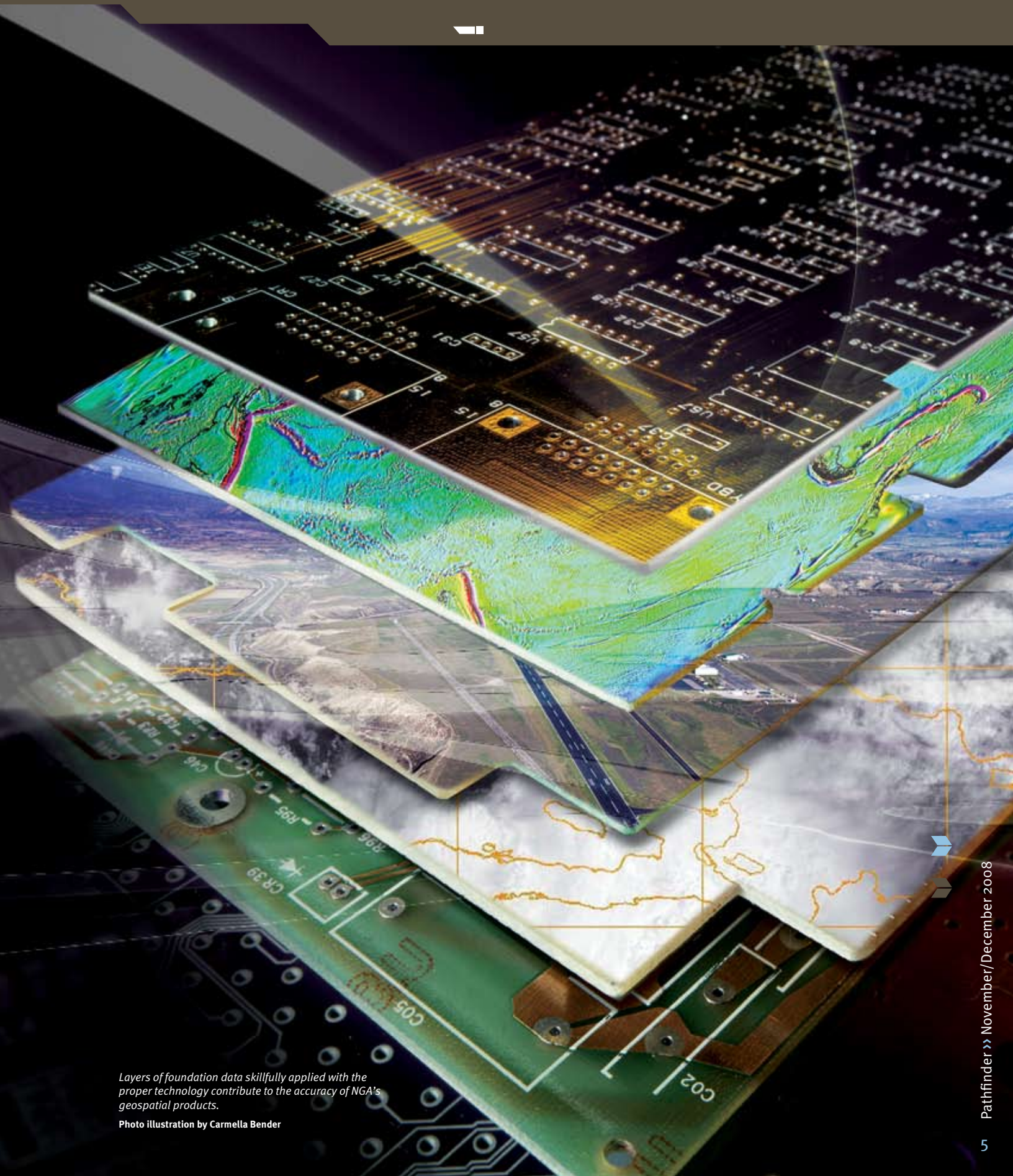
NGA remains committed to maintaining a strong research and development program. Our challenge is balancing the budget to address all competing requirements. For example, as sources of data increase, so does our drive to evolve to a sensor-neutral architecture. NGA must stay on the forefront, ready and able to adapt, exploit, and use the data collected from all possible sources, develop a common ground and community information technology and assist in providing multi-intelligence (multi-INT) fusion capabilities. Future phenomenologies like hyperspectral, multispectral and polarimetric imagery will help unlock the toughest intelligence problems.

Deploying the Mission to New Campus East

New Campus East (NCE) provides the first opportunity for GEOINT to truly have a new mission home in the East. Like our sister agencies, NGA will now benefit from bringing our forces together and working with the Commonwealth and other agency representatives in the same facility. The next 18 months are critical to our success in moving the GEOINT mission forward. The importance of our core sites in St. Louis and Arnold, Mo., will be even greater during and after our mission deployment to NCE. These locations are key to dispersed operations, breadth of mission and continuity of efforts.

As we move forward and address these challenges, the GEOINT community approaches the biggest leap forward in our tradecraft evolution—the move to predictive analysis. I am certain there will come a day when the combination of great people, technology, and multi-INT fusion will enable an analyst to say, with a high degree of certainty, where the next improvised explosive device plantings will be or where the next Al Qaida cell will be employed. This predictive analysis will allow our mission partners to move quickly to interdict with a greater probability of success through actionable intelligence. That is our ultimate goal, after all—operational success, national security and the saving of lives. Thanks to everyone who makes the power of GEOINT possible. Know the Earth, Show the Way! 





Layers of foundation data skillfully applied with the proper technology contribute to the accuracy of NGA's geospatial products.

Photo illustration by Carmella Bender



UP FRONT

Agency Applauds Launch of GeoEye-1 Satellite

On Sept. 6, NGA and the geospatial intelligence community applauded the successful launch of GeoEye-1, a new source of high-resolution color imagery. GeoEye-1 is the second commercial imaging satellite developed under NGA's NextView program.

GeoEye officials report that the satellite is functioning properly. Following the launch, NGA Director Vice Adm. Robert B. Murrett commented, "Everything so far in terms of the initial testing has been successful, it is tracking as it should be, and we look forward to getting the initial images." On Oct. 8, GeoEye released the first image collected from the satellite, a view of Kutztown University in Pennsylvania. GeoEye anticipates beginning commercial sales of GeoEye-1 imagery in late 2008.

NGA initiated the NextView program as a partnership with the commercial remote sensing community to ensure access to commercial imagery in support of national security. Speaking of NextView and the agency's commitment to its commercial partnerships, Murrett stated, "We are the single strongest supporter of the commercial remote sensing industry. It is absolutely integral to our success and is a fundamental building block of what we do as an agency." ▢



Liftoff of the GeoEye-1 satellite at 11:50:57 a.m. PDT from Space Launch Complex 2 West at Vandenberg Air Force Base, Calif.

Photo by Carleton Bailie, ©2008 Boeing

UP FRONT

ODNI Vision 2015 Expands View of Intelligence Enterprise

This summer the Office of the Director of National Intelligence (ODNI) published *Vision 2015: A Globally Networked and Integrated Intelligence Enterprise* to chart a new path for how Intelligence Community (IC) agencies will work together in the 21st century. Given that the vision's principles of integration, collaboration and innovation are already part of NGA's culture and strategic planning, how will Vision 2015 change NGA?

ODNI's mission is to create "decision advantage" for policymakers, warfighters, homeland security officials and law enforcement personnel, all of whom NGA serves daily to meet its mission. To help create decision advantage as part of Vision 2015, NGA will contribute geospatial intelligence (GEOINT) within the framework of the IC's customer-driven intelligence.

For example, NGA will continue to fuse

NGA's processes with other IC processes to fit into the ODNI's operating model and result in new mission-focused capabilities. NGA analysts will continue to deepen their own expertise by importing other IC expertise into NGA's processes. NGA will participate in joint IC projects as a way of life, having fewer processes that are confined, or "stovepiped," within the agency. IC agencies will work toward removing barriers to cross-agency collaboration, training, facilities and other resources that can be shared to achieve a net-centric information enterprise that is agile, lean and flexible enough to respond to a dynamic environment.

To guide the way to 2015, the ODNI is implementing a strategic roadmap to serve as the basis for planning and budget programming. IC agencies are involved in shaping the roadmap and the major actions and milestones needed to achieve the vision. The more the vision is discussed among IC members, the better the IC will be integrated by 2015.

The DNI has stated that a vision without a map is just a wish. As ODNI completes the strategic roadmap and IC agencies adopt Vision 2015, a globally networked and integrated intelligence enterprise will become reality, creating decision advantage with GEOINT.

The Vision 2015 document is available on the ODNI Web site, www.odni.gov.

VISION 2015

NGA: GPS Consumer and Contributor

BY VICE ADM. ROBERT B. MURRETT, DIRECTOR, NGA

Over the past decade, the NAVSTAR Global Positioning System (GPS), managed by the U.S. Air Force (USAF) Space Command for the Department of Defense (DOD), has become the most exploited space-based asset that the U.S. government has ever developed. Since GPS provides space-based radio navigation for anyone with a GPS receiver, both military and civilian uses have increased exponentially.

In fact, everything geospatially oriented today is reliant on GPS. Most military and intelligence operations depend on knowing precisely where something is located. NGA's mission is to provide the accurate, timely and actionable geospatial intelligence (GEOINT) to our mission partners, when and where they need it most. From the warfighter on the front line to the local search-and-rescue team seeking flood victims, NGA provides GEOINT to support operational and decision-making needs.

For example, we provide the geospatial products that enable our warfighters—soldiers, sailors and airmen—to accurately locate and hit targets. Our analysts will build a picture for the warfighter by layering natural features, such as rivers, hills and waterways, with man-made features, such as roads, power lines and buildings, to develop a 2-D or 3-D picture for common use. Knowing that a target of interest exists is important; knowing where exactly that target of interest is located ensures accurate targeting and minimizes the risk of collateral damage. To target an object, the warfighter needs accurate geographic coordinates. Subsequently, each data layer used in the development of a GEOINT product is referenced to a standard coordinate system.

Ensuring Accuracy and Reliability

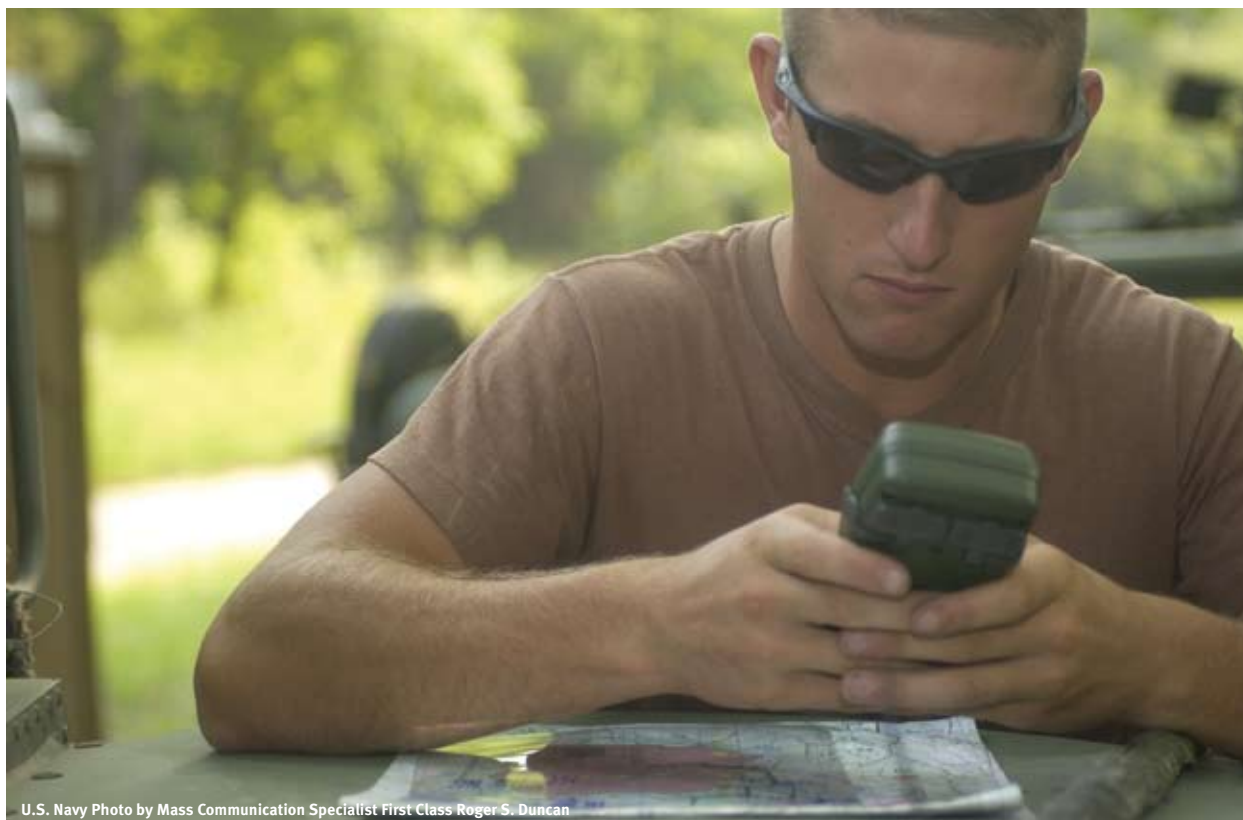
U.S. national security, transportation and navigation safety, economic interests and scientific uses all rely on GPS. This increasing dependence demands that the coordinate information and reference system be both accurate and accessible. NGA plays an essential role in maintaining and improving the accuracy and reliability of GPS by providing the DOD with precise GPS orbits, satellite and station clock corrections and Earth orientation information. NGA is not only a daily consumer of GPS but a robust contributor as well.



Satellites like this one form the NAVSTAR Global Positioning System constellation.

NGA and its predecessor organizations partnered with the DOD to develop the World Geodetic System 1984 (WGS 84) as the standard geodetic frame of reference. The WGS 84 global reference frame provides a mathematical representation of the Earth's shape, a 3-D coordinate system, and a gravity model that is essential for computing satellite orbits and precise locations on, above or below the Earth's surface. WGS 84 provides a common, standardized reference frame for interrelating and integrating all geospatial data, including GPS-derived position location information. This global reference information is what allows users to determine their locations on Earth based on the precise positions of GPS satellites in space.

Prior to the 1950s, coordinate systems were developed regionally. Once satellites became available in the 1950s and 1960s, we were able to establish an Earth-centered, global coordinate system. Today, the WGS 84 coordinate system, used by GPS, is defined by the 3-D coordinates established by the combination of the Air Force and NGA satellite tracking stations distributed around the world. The more accurately we know the positions of these tracking stations, the more accurately we can determine the GPS satellite positions. Currently, we estimate the accuracy of these station coordinates within a few centimeters or less. As a by-product of this data processing,



U.S. Navy Photo by Mass Communication Specialist First Class Roger S. Duncan

A U.S. Navy seaman practices navigational skills using a GPS unit.

we can also detect small variations in the Earth's orientation in space and its rotation rate. This information is crucial for the accurate and precise orientation and geopositioning of satellite imagery.

Precise timing is the key to GPS's accuracy. Every DOD GPS tracking station and GPS satellite is equipped with an atomic clock, each of which runs at slightly different rates. NGA collocated a tracking station with our nation's master timekeepers at the U.S. Naval Observatory (USNO) in Washington, D.C. This allows us to take advantage of the stability, precision and accuracy of the USNO time by defining it as our GPS "master clock" and then to adjust all the other satellite and station clocks to the master.

Reliability of service is essential to GPS effectiveness. Beginning in the 1980s, NGA provided personnel support at the GPS Joint Program Office (now the GPS Wing) at Los Angeles Air Force Base (AFB) and the Operational Control Station (OCS) at Schriever AFB in Colorado Springs. Additionally, we invested in building and operating a

global network of unmanned GPS tracking stations to augment the Air Force's permanent GPS tracking stations. The result has been substantial benefits to the entire GPS user community. As part of a major accuracy improvement initiative, NGA stations now feed real-time data to the GPS through the OCS at Schriever AFB. These data are incorporated into the real-time estimation process for GPS orbit determination, resulting in increased accuracy and integrity of GPS navigation signals for GPS users.

Looking Forward

Future improvements and maintenance of GPS, augmentations and backup capabilities are necessary to meet growing national security, economic, commercial and scientific requirements and opportunities. For example, new foreign-based Global Navigation Satellite Systems (GNSS), such as the Russian GLONASS and the European Galileo System, provide additional options for current and future GPS users. These foreign systems are not yet as robust as our GPS system but may be in future years.





With ongoing efforts to ensure interoperability among all the systems, every system may be vulnerable to the same intentional or unintentional interference. The sheer number of combined GNSS satellites, upwards of 60–100 in the future, may help to mitigate these effects. The defense community is exploring new mitigation strategies to counter electromagnetic radiation interference caused by solar flares or geomagnetic storms, as well as intentional and unintentional radio jamming caused by man-made techniques. DOD's development and implementation of a military-only code and other new satellite features are designed to protect and preserve U.S. strategic access to GPS, even in hostile environments.

As we look toward the future and the next evolution of GPS, we must ensure interoperability and compatibility in the context of geospatial information. NGA will continue our strong collaboration with the USAF to ensure future satellite procurement and technological decisions consider GEOINT needs and capabilities. Additionally, NGA's continued participation in the International GNSS Service, the international organization that produces state-of-the-art GNSS data and products for the scientific community, will also help ensure that NGA stays up-to-date on the latest GNSS science and technology.

As both a consumer of and a contributor to GPS, NGA is committed to integrating and working collaboratively with our mission partners as we make the best decisions to ensure our national security, safety and stability.

This article also appeared in the May 2008 issue of High Frontier, a publication of the Air Force Space Command. P



Photo illustration by Carmella Bender
Original photo by U.S. Air Force, Airman 1st Class Jonathan Snyder

Earth Gravitational Model Advances GEOINT Sciences

BY DR. NIKOLAOS K. PAVLIS

On April 17, 2008, NGA officially unveiled the latest and most accurate global model of the Earth's gravitational field: Earth Gravitational Model 2008 (EGMo8). Making this new and unrestricted model available to the public confirms NGA's leading geospatial role within the worldwide scientific community.

A Global Need

Many people may recall from their high school physics that on the surface of the Earth, the acceleration of gravity is 9.8 meters per squared second. Most physics textbooks don't mention the fact that this is only an average value or that variations of the Earth's topography, bathymetry, geology and other geophysical features affect the acceleration of gravity at a given spot on the Earth. The precise determination of these gravity variations is the focus of the branch of science called gravimetric geodesy. A long-standing goal of this discipline is the determination of the gravity field of the Earth at the highest possible resolution and with the highest possible accuracy, anywhere on or above the Earth. The encapsulation of this information into a set of parameters that mathematically describe the gravity field is called a gravity field model. Some models of the Earth's gravity field are global and may be used to estimate any type of quantity related to the field anywhere on or above the Earth, while others are regional or local and may be used to estimate only certain quantities related to the field over a given geographic area. The accuracy of any gravity model depends primarily on the accuracy of the data that were used to create it and secondarily on the rigor and expertise with which these data were treated.

Global models are inherently superior to regional models, especially for NGA's interests and for NGA customers who use this information for Department of Defense (DOD) or Intelligence Community applications. In part because they require more effort to create, global models have historically lagged behind regional and local models in terms of resolution by a considerable amount. This situation changed dramatically when NGA officially unveiled EGMo8 and made it publicly available to all. This new global gravity model not only describes

the gravity field for the entire planet but does that at a resolution comparable to that of regional models and with accuracy that in some cases surpasses the accuracy of regional models. In the same fashion as the geometric portion of the World Geodetic System 84 (WGS 84) reference frame has replaced the myriad of local and regional geodetic reference frames (datums), thus providing much-needed uniformity and consistency among DOD users, EGMo8 now enables a dramatic advancement in NGA's quest for higher accuracy of the global vertical reference frame and the highly accurate targeting products NGA supplies to DOD customers. Since this gravity model is unclassified, many scientific applications are also possible. For example, scientists can use this model to improve understanding of global ocean circulation, which is important to global climate studies.

A Global Solution

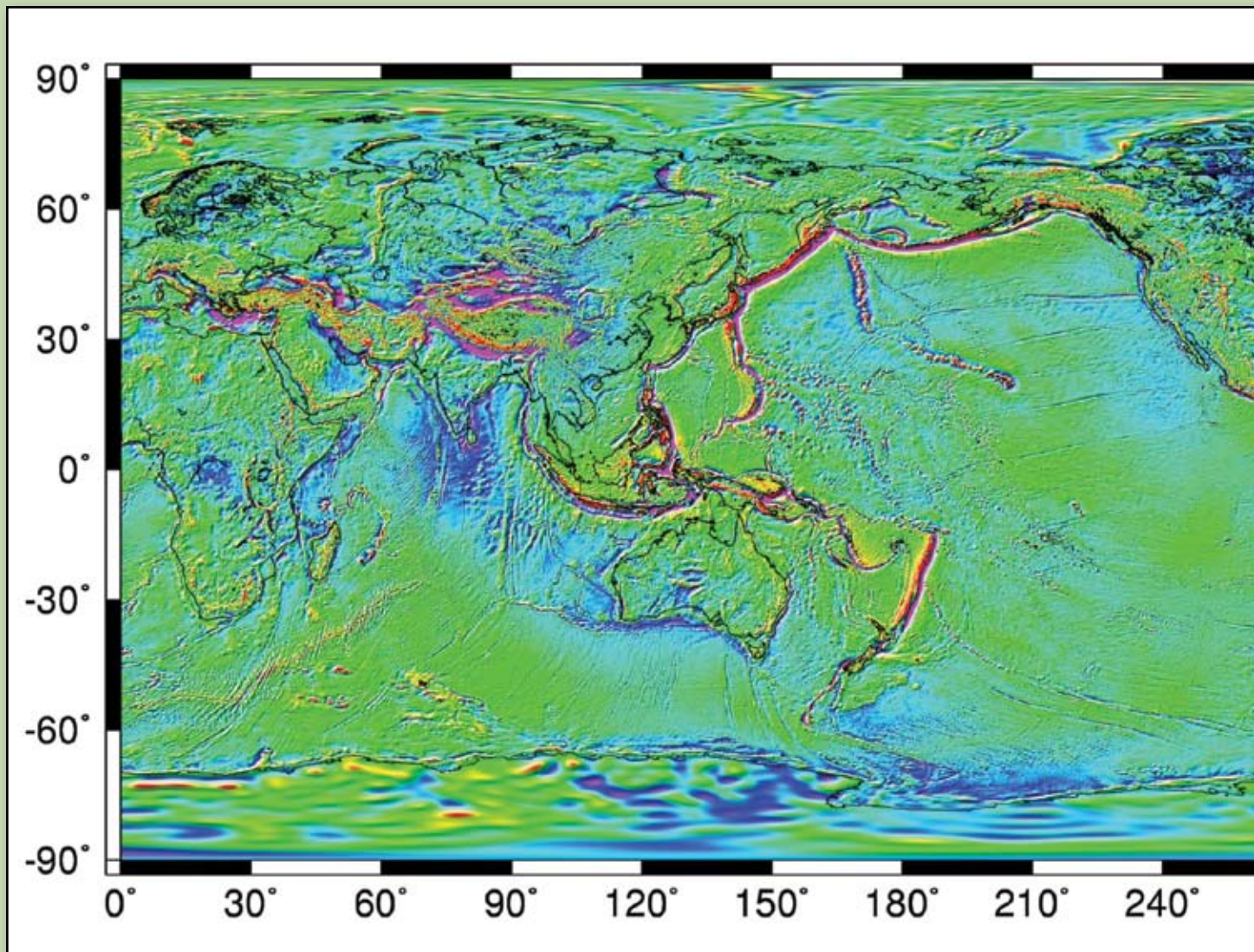
Before EGMo8, the global model of choice for many applications was EGM96, which was developed jointly by NASA's Goddard Space Flight Center, the National Imagery and Mapping Agency (NGA's predecessor) and The Ohio State University. EGM96 required approximately 130,000 parameters to be estimated for its numerical realization and could support a nominal resolution of 30 minutes of arc, which corresponds to about 55 kilometers on the equator. Within EGM96, the long wavelength portion of the model, which describes the broad features of the field, required the processing of satellite tracking data acquired over decades, from tens of different spacecraft. In contrast, for EGMo8, 57 months of the highly accurate data from the Gravity Recovery and Climate Experiment (GRACE) mission—the first satellite-to-satellite tracking mission ever launched where both satellites orbit at low altitude—were enough to support the estimation of the long wavelength portion of this model 100 times more accurately than was possible for EGM96. This long wavelength portion of the model is critical for the accurate determination of the geoid surface (approximately the Earth's mean sea level extended through land). While EGM96 was capable of supporting the determination of the geoid with an average accuracy



of about ± 50 centimeters and a nominal resolution of 30 minutes of arc (55 kilometers), EGM08 can support geoid determination with an average accuracy better than ± 15 centimeters and a nominal resolution of 5 minutes of arc (corresponding to 9.3 kilometers on the equator). Thus, with EGM08 NGA is now realizing more than three times higher accuracy at six times higher resolution, compared to EGM96.

The determination of the high-resolution component of EGM08 over land areas depended critically on the availability of elevation data from the Shuttle Radar Topography Mission (SRTM), which cover more than 80 percent of the Earth's landmass. To achieve this

higher resolution, EGM08 required the estimation of approximately 4.7 million parameters, which are necessary to define the model numerically. Most users of the model are interested not only in the model's products, but also in reliable accuracy measures associated with these products. This requires the estimation of errors associated with each one of these 4.7 million parameters within a well-defined statistical framework. The solution of such a large estimation problem required the development of an estimation strategy and the implementation of highly innovative analytical and numerical methods, which have become the envy of many theoreticians and practitioners within the discipline.

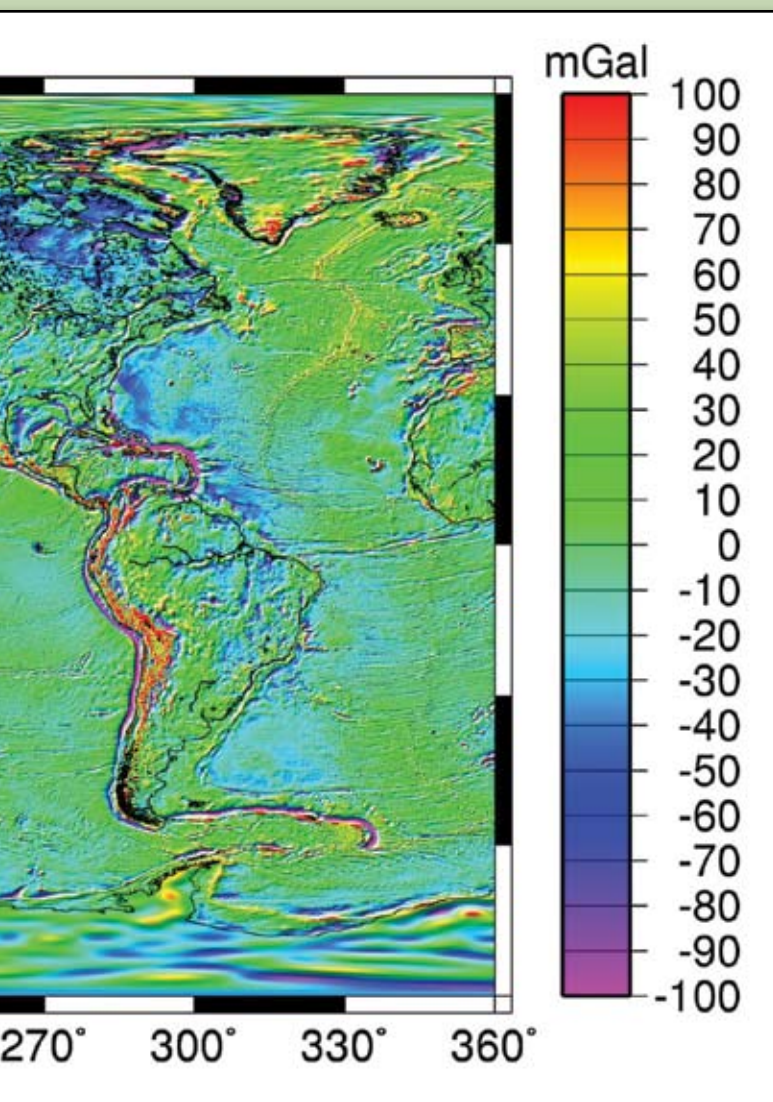


The development of EGMo8 was possible only because of the long-term close collaboration between the Geodesy and Geophysics Division of NGA's InnoVision Directorate and Office of GEOINT Sciences. InnoVision provided the research and development resources, the technical leadership for the project and the rare analytical and numerical expertise required for global gravity field modeling, estimation and validation. The Office of GEOINT Sciences provided specialized geodetic expertise and large, processed, carefully selected unique data sets, including a custom-developed subset of the NGA gravity data holdings that contains more than 55 million point gravity measurements. EGMo8 required the effort

of four individuals over approximately four years, and in this regard it has been developed at a comparatively low cost to NGA. The worldwide interest generated by the announcement of the initiation of this project in 2004 made it also possible to benefit from the contributions of national and international partners. These have provided valuable input to this effort, in the form of gravity data contributions, in the processing of satellite altimetry data over the oceans, in terms of feedback from the evaluation of preliminary solutions, etc., all at no cost to NGA.

With EGMo8, NGA has achieved a quantum leap towards establishing a new state of affairs in gravimetric geodesy, whereby a single model can be used to support an extremely wide variety of applications. These include highly accurate orbit determination for artificial satellites, geoid computations necessary to achieve a representation of mean sea level around the world, the estimation of other gravimetric quantities known as "deflections of the vertical" and several others. All of these identified applications are important to DOD and Intelligence Community customers. Finally, the achievement of EGMo8 brings an intangible, yet highly significant benefit to NGA—introduction of this groundbreaking gravity model has secured an indisputable leadership role for the agency in applied geodetic research.

EGMo8 resources can be found on the Web at:
<http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm2008/index.html> P



DR. NIKOLAOS K. PAVLIS

is a Project Scientist in the Geodesy and Geophysics Division of NGA's InnoVision Directorate. His research focuses on very high resolution global and regional gravity field determination.



Gravity anomalies computed from EGMo8 reveal numerous geophysical features, such as oceanic trenches, ridges, subduction and fracture zones and seamount chains.

Graphic provided by NGA



Analyst Group Establishes Boundary Truth

BY WAYNE P. SCHNEIDER AND DENISE DAMSCHROEDER

Frontier issues are at the heart of many of today's geopolitical conflicts. Political boundary information—the location and status of international and administrative boundaries, both terrestrial and maritime—is a fundamental component of geospatial intelligence (GEOINT). Increasingly stringent requirements for more accurate and authoritative boundary information have compelled NGA and its partners to take a more systematic and rigorous approach to boundary analysis.

International boundaries are often the focus of global problems that can incite crises. Resolving border conflicts and managing cross-border movement requires a clear understanding of where a legally defined boundary falls on the ground. Policymakers, diplomats, analysts, coalition forces and others increasingly expect accurate and timely GEOINT from NGA regarding the location and status of political boundaries.

Many modern international boundaries were delineated at a time when the geography and cultural landscape were unknown, leading to much disharmony among nations and sometimes to open warfare. In 1890, British Prime Minister Lord Salisbury observed:

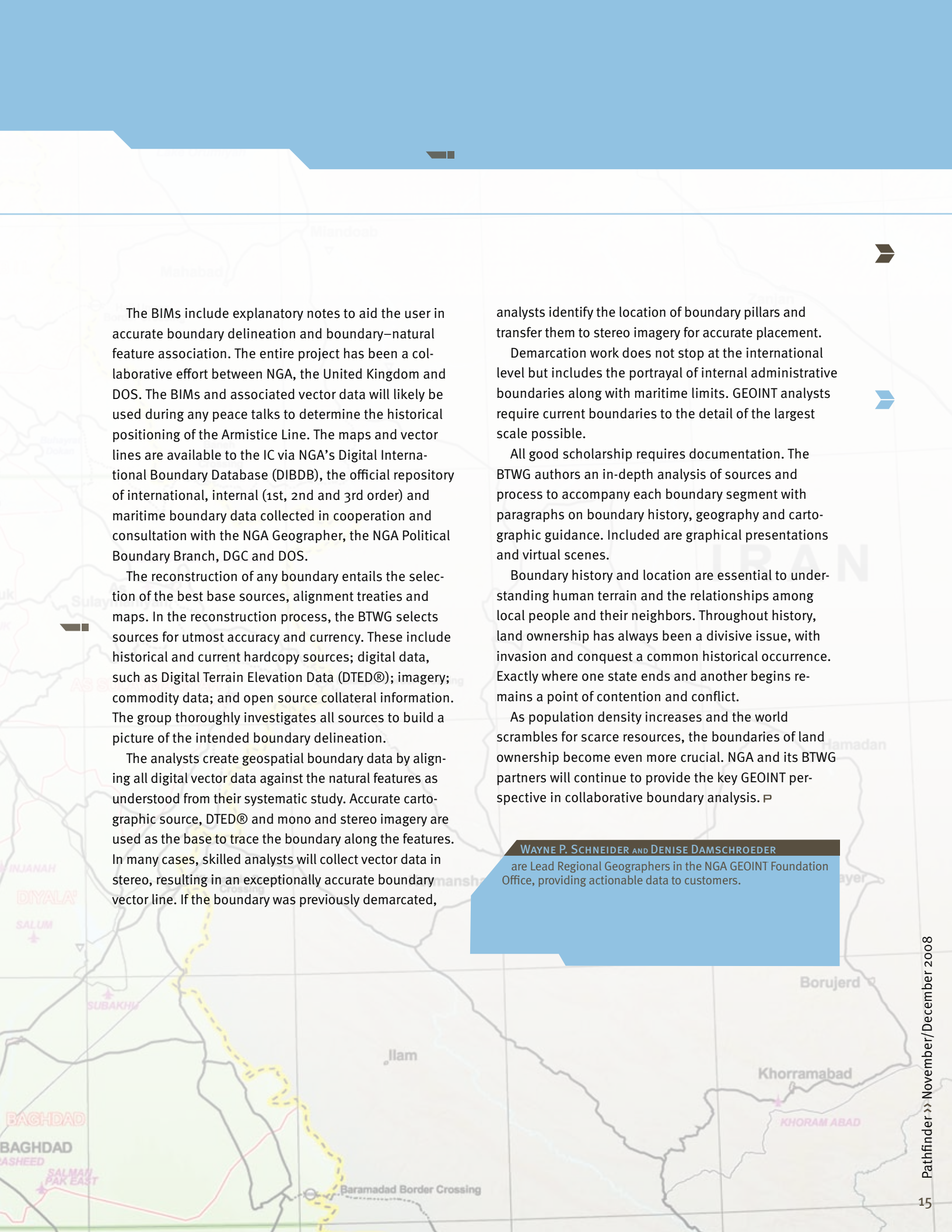
We have been engaged in drawing lines on maps ... giving away mountains and rivers and lakes to each other, only hindered by the small impediment that we never knew where the mountains and rivers and lakes were.

Sorting out U.S. government policy and creating geospatial truth related to boundary location is the combined job of analysts at the Department of State's (DOS's) Office of the Geographer and Global Issues,

NGA GEOINT analysts within the Source Operations and Management Directorate and Analysis and Production Directorate, and boundary analysts at the United Kingdom's Defence Geographic Centre (DGC). The unified forces of these organizations have produced the most accurate international boundary data in mapping and geospatial history. Known as the Boundary Technical Working Group (BTWG), these analysts meet to discuss boundary issues, policy, theory and processes to ensure that only the most correct boundaries are distributed throughout the Intelligence Community (IC). The group is constantly searching for new technology and methods for the dissemination of boundary information.

Boundary work requires an in-depth knowledge of geospatial tools and research principles. To fully understand the issues surrounding international lines, BTWG analysts carefully study national political history, international boundary history, culture, environment and resources.

Recently the group accomplished an in-depth analysis of the 1949 Armistice Line that separates Israel from the West Bank in support of the ongoing Middle East peace process. Analysts researched and reviewed original treaty maps augmented with current materials to depict the line to the highest degree of accuracy to date. In addition, the group revised and updated with imagery the depiction of the security barrier that physically separates much of Israel from Palestinian areas in the West Bank. The analysts completed a series of 28 Border Image Maps (BIMs) portraying both the Armistice Line and the Security Barrier.



The BIMs include explanatory notes to aid the user in accurate boundary delineation and boundary–natural feature association. The entire project has been a collaborative effort between NGA, the United Kingdom and DOS. The BIMs and associated vector data will likely be used during any peace talks to determine the historical positioning of the Armistice Line. The maps and vector lines are available to the IC via NGA’s Digital International Boundary Database (DIBDB), the official repository of international, internal (1st, 2nd and 3rd order) and maritime boundary data collected in cooperation and consultation with the NGA Geographer, the NGA Political Boundary Branch, DGC and DOS.

The reconstruction of any boundary entails the selection of the best base sources, alignment treaties and maps. In the reconstruction process, the BTWG selects sources for utmost accuracy and currency. These include historical and current hardcopy sources; digital data, such as Digital Terrain Elevation Data (DTED®); imagery; commodity data; and open source collateral information. The group thoroughly investigates all sources to build a picture of the intended boundary delineation.

The analysts create geospatial boundary data by aligning all digital vector data against the natural features as understood from their systematic study. Accurate cartographic source, DTED® and mono and stereo imagery are used as the base to trace the boundary along the features. In many cases, skilled analysts will collect vector data in stereo, resulting in an exceptionally accurate boundary vector line. If the boundary was previously demarcated,

analysts identify the location of boundary pillars and transfer them to stereo imagery for accurate placement.

Demarcation work does not stop at the international level but includes the portrayal of internal administrative boundaries along with maritime limits. GEOINT analysts require current boundaries to the detail of the largest scale possible.

All good scholarship requires documentation. The BTWG authors an in-depth analysis of sources and process to accompany each boundary segment with paragraphs on boundary history, geography and cartographic guidance. Included are graphical presentations and virtual scenes.

Boundary history and location are essential to understanding human terrain and the relationships among local people and their neighbors. Throughout history, land ownership has always been a divisive issue, with invasion and conquest a common historical occurrence. Exactly where one state ends and another begins remains a point of contention and conflict.

As population density increases and the world scrambles for scarce resources, the boundaries of land ownership become even more crucial. NGA and its BTWG partners will continue to provide the key GEOINT perspective in collaborative boundary analysis. ▢

WAYNE P. SCHNEIDER AND DENISE DAMSCHROEDER

are Lead Regional Geographers in the NGA GEOINT Foundation Office, providing actionable data to customers.

Consolidated Analytic Spatial Initiative Aggregates Scattered Data

BY JOHN A. DUNCAN AND EMILY KILMAN

For years, analysts have recorded a multitude of valuable geospatial features that are often overlooked in standard collection. This ad hoc feature data has tended to remain stored in “shoeboxes,” typically available only to the analysts who originally noted it. Now, an NGA initiative is expanding access to this valuable data for the agency and its partners. The Consolidated Analytic Spatial initiative (CASI) improves geospatial intelligence (GEOINT) sharing among analysts within NGA, the Intelligence Community (IC) and the Department of Defense (DOD).

To an urban planner, a manhole cover is a cast-iron disc that allows access to underground infrastructures. But to an insurgent or terrorist, it can be a portal to insert guerillas or explosives. To an imagery analyst, a manhole cover can be worth noting. Yet manhole covers—and other often overlooked commonplace features—are not included in standard feature databases.

The various systems that make up CASi enable analysts to collect, discover and share access to vast amounts of nonstandard GEOINT data. CASi incorporates new and emerging information and technologies to support the discovery, dissemination and analysis of GEOINT feature data within a system compliant with Open Geospatial Consortium standards.

The original call for CASi came about two years ago, when analysts from NGA’s Analysis and Production Directorate voiced concerns at the difficulty of storing and sharing data that did not conform to standards, yet had obvious value to their work. NGA Director Vice Adm. Robert B. Murrett understood these concerns and instructed the agency to remedy the situation, leading to the establishment of the CASi program office within the Analysis and Production Directorate. While the CASi staff put together full processes and plans to stand up the related systems, they also made a CASi prototype available at NGA’s Washington, D.C., and Bethesda, Md., facilities to provide analysts an interim capability to load data and encourage them to suggest improvements to the CASi interfaces. During the development and implementation phases, CASi benefitted greatly from a bridged development approach that took advantage of the complementary skills of NGA personnel from each directorate, in collaboration with the program office, to develop and maintain a system that provides data storage, management, discovery, retrieval, analysis and accessibility of nonstandard GEOINT features.

The three CASi program segments—CASI-Internal (CASI-I), CASi-External (CASI-E) and CASi-Forward

(CASi-F)—were created to facilitate and enhance analytic exchange, yielding sharable knowledge for the IC. The CASi infrastructure design promotes GEOINT interoperability across networks, hardware platforms and operating systems.

CASi-I allows analysts to aggregate, manage, search, discover and share nonstandard GEOINT data. CASi-I servers allow analysts to utilize the data without having to download it, saving limited computer space and delivering data consistently across the network.

CASi-E extends data-sharing capabilities to NGA, the IC and DOD. Analysts can share their data with the wider IC by loading it to the CASi-E servers, search for features relevant to their work loaded by other analysts, and add value to the data by rating and commenting on it.

CASi-F provides forward-deployed GEOINT analysts a hybrid of CASi-I and CASi-E, offering data gathering and distribution capabilities for nonstandard country datasets and products to analysts working side by side with warfighters. A CASi-F system was deployed to Baghdad in June 2008, and CASi-F for Afghanistan is currently under development.

To load data to CASi systems, users complete a few elements of standard geospatial metadata.

These provide the framework for users to locate relevant features, understand their history and purpose, and contact the data producer for further collaboration.

The program office develops and releases CASi elements on a spiral schedule. Program segments were initially released at 65–70 percent of their intended capability. Subsequent releases provide additional functionality several times a year. Analysts who use the CASi systems guide this spiral development by commenting on current capabilities and suggesting functions that they would like to see in future releases.

The accuracy of GEOINT analysis only improves as analysts more fully aggregate and share the nonstandard feature data they each discover. At the forefront of the effort to collect and share these important resources, CASi effectively extends the analysts' ability to support the IC, DOD and the warfighter. ▢

JOHN A. DUNCAN (LEFT) AND EMILY KILMAN (RIGHT)

John A. Duncan is a Regional Analyst and CASi Representative in the GEOINT Foundation Office, supporting the National System for Geospatial Intelligence.

Emily Kilman is a Geospatial Data Steward in the GEOINT Foundation Office, assigned to the CASi Program Office.





Urban Feature Data Sharpens the Warfighter's View

BY GREGORY WAGNER

Urban Feature Data (UFD), one of many NGA products serving the warfighter, has proven effective in the Global War on Terrorism (GWOT). This high-density urban area vector data can be overlaid on imagery depicting areas of high interest for use by intelligence operatives and special operations forces. UFD is part of an initiative to fuse multiple intelligence sources, ground movement target indicators and other data to provide actionable intelligence to frontline operators.

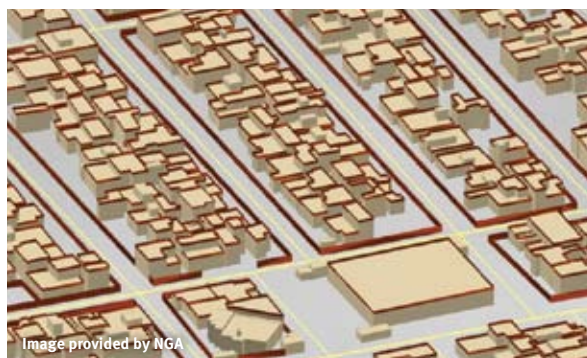
Since 2003, UFD has provided NGA analysts and partners with the data needed to make better decisions as the landscape of today's war zone transitions to an urban environment. UFD supports urban planning operations to help both the military and the Intelligence Community to fight the GWOT.

UFD has helped fill the increasing demand of the modeling and simulation community for site familiarization and route-, mission- and target-planning data. UFD's high-density geospatial data, when combined with other intelligence sources, provides the necessary spatial context for identifying key terrain, cultural, and street-level features required to track persons of interest. The following hypothetical example illustrates UFD's utility:

Information indicates that a person of interest is staying at a hotel one block from a government facility. Additional information places the target in the vicinity of a named road. Neither the hotel, facility nor road can be easily identified from imagery alone. To provide context, UFD can be quickly overlaid on imagery that has been georegistered to known geographic control points. Analysts can then search the extensive UFD attributes to find the features efficiently and locate the person of interest.

Intended for use within geographic information systems, UFD has evolved to offer three levels of enhanced 2-D or 3-D vector data over urban and some rural areas. The data is primarily extracted from stereo imagery. More current commercial imagery is used to update the data set.

Direct feedback on the product has been extremely positive. One user remarked that "Urban Feature Data for Baghdad, Samarra, Kirkuk, Kabul and Hit will aid the user in creating a detailed product for any mission, route and target planning in these cities. While this is a good find from a 2-D perspective, it is even more useful from a 3-D perspective. Because the UFD shapefiles include building data along with height values for each structure, the



Individual buildings and an extensive system of walls are illustrated in this example of Urban Feature Data.

data can be loaded into Terra Vista [scene visualization software] to create a 3-D build of the entire area."

Another user stated that "UFD is a valuable tool for tactical line-of-sight requirements in urban operations on or near the ground, in addition to site familiarization. We also like its use in navigation—good representation of landmarks—and its use as an urban planning graphic."

The GEOINT Foundation Office (SG) within NGA's Source Operations and Management Directorate manages NGA's UFD program with support from the Office of Commercial Partnerships. Almost all UFD data has been produced by commercial vendors. However, SG cartographic analysts have recently begun work on NGA's first in-house UFD data set.

NGA faces many challenges regarding UFD's future. With the increasing demand for the product, NGA is investigating how best to disseminate and distribute UFD to the user community. The program faces additional challenges, including standardizing UFD, creating common specifications among its variations, and updating the product to remain current. Nevertheless, given its proven benefits and NGA's dedication to solving these challenges, the ever-improving UFD will remain crucial to the warfighter for a long time to come. ▢

GREGORY WAGNER

is a Cartographic Analyst in NGA's Source Operations and Management Directorate, GEOINT Foundation Office, where he supports the Urban Feature Data program.



Office of Global Navigation Accelerates Technology to Meet the Future

BY MARK MUNSELL

What does a geospatial intelligence (GEOINT) analyst need to confront a world of complex threats and rapid change? The essential requirement, in a word, is data—abundant current and historical information with which to understand a situation and draw conclusions—and the faster the better. The analyst also needs tools to manipulate data and seamless lines of communication to reach other analysts to collaborate.

NGA's Office of Global Navigation is working to create a setting that would provide all of these attributes. Consider how a hypothetical day might unfold in such an environment:

Upon logging in, a maritime analyst receives several messages from collaborative partners, including some unexpected tip-offs about important changes in the navigation infrastructure within the analyst's geographic area of interest. After a quick review, it's apparent only one of the tip-offs requires immediate attention. The analyst retrieves fresh GEOINT from the source management system through a simple and direct interface. The infrastructure behind it can input host-country navigation publications at a furious rate. This system contains every paper and digital navigation product known to exist, indexed and searchable both geospatially and via keywords.

The analyst enters a foreign port into the search field and, within moments, results start flowing, including:

- » Six host-country published, scanned nautical charts, at various scales, coverage and dates
- » Two new foreign partner electronic nautical charts
- » Two other foreign nautical charts, scanned and georeferenced
- » Two open source articles published by U.S. and foreign newspapers on recent activity in this port, including which contractor performed the work and its estimated value
- » The most recent commercial reports on port activity, fuel prices, piracy and traffic, plus a variety of open source information from Wikipedia, Google™, etc.
- » Two bathymetric surveys of unknown origin
- » A recent Notice to Mariners published by the host country



U.S. Navy photo by Mass Communication Specialist 1st Class Christopher Fowler

U.S. Navy crews depend on accurate information to navigate safely. NGA is working to accelerate the analysis and delivery of essential maritime data.

Nothing in the source appears suspicious, but the analyst digs deeper. Based on metadata associated with the query's original results, the analyst clicks on the newest chart from a foreign partner, and it opens in a geographic information system (GIS) window. The analyst repeats the process for other charts, a bathymetric survey and an outline of a commercial image.

In the GIS, the analyst adjusts the order and transparency of the data layers. The analyst then brings up layers from the Maritime GEOINT database and compares the recently added source to the current database that is transmitted to NGA's Department of Defense (DOD) customers weekly. The comparison reveals several significant feature changes. The analyst then receives an instant message from an imagery analyst that all inbound traffic is at a halt offshore waiting entry into the port. The analyst immediately adds the live feed and latest airborne imagery and lays it over the current database.



Shockingly, much of the port is destroyed, though the cause is unclear.

Immediately, the analyst begins a videoconference with the partner who provided the initial tip-off. The analyst includes an aeronautical analyst as similar destruction to an airfield is discovered. Then several senior analysts join the conversation to lay out a plan of action—one of the first steps being to alert ships in the area of the port closure via a broadcast warning message. Working together, the analysts begin to “data intensify” all of the nautical and aeronautical charts in the region for possible immediate military operations or humanitarian relief missions.

From an operational standpoint, this scenario depicts far swifter and deeper access to maritime source data than analysts currently have. And it describes a quantum leap in the ease of collaboration. Yet, from a technical standpoint, this scenario is not far-fetched. All of the technologies described are available today.

This begs a critical question, namely: Why doesn’t NGA have such a system right now? The reason is that the challenge of building such a capable system is not just technical but logistical. The goal is in sight, but NGA will only achieve it through the heavy lifting of integrating data and systems and making total functionality accessible to its analysts. The following will have to be developed to realize this concept of operations:

- » A robust system of source ingest, archiving, indexing and retrieval fed by many sources.
- » A database that every analyst can access, with current safety of navigation and navigation infrastructure, information and intelligence data. Aeronautical and maritime analysts can update this database dynamically, as well as nominate updates from outside sources.
- » Tools to easily compare, overlay, ingest and merge data from the source management system.
- » Tools to support and use the persistent surveillance, Web-based geospatial visualization and community collaboration of the NGA time-dominant operating picture for information development, data fusion and situational awareness.

NGA will transform to create this future operational state, beginning with two ambitious pilot projects of the Global Navigation Services (GNS) for the Aeronautical and Maritime Domains. Currently, maritime feature data resides on 29 CDs held in hundreds of Digital Nautical Chart libraries. The goal is to build a database for maritime feature data—a groundbreaking feat in itself—and design this system to rapidly deliver Digital Nautical Charts on demand. The present GNS-Aeronautical database is 10 years old and strains under a software architecture that is no longer supported. Beyond ensuring higher reliability, the new, more robust aeronautical database will incorporate additional feature data, updated data standards and new product lines, such as Stereo Airfield Collection.

Implementation of both GNS pilots will follow a phased approach for smooth integration into the entire system in a service-oriented architecture that facilitates cross-organizational publishing of information. Further, both databases will employ network-attached storage to facilitate data sharing. Compliance with Open Geospatial Consortium standards will make these pilot databases more interoperable and accessible to NGA’s partners in DOD and the Intelligence Community.

The ultimate goal of both pilots is to provide one-touch maintenance of safety of navigation in a database environment, where digital source data are automatically ingested and fused, and where products are created directly from the database, regardless of whether the source material is textual, digital or hardcopy. This environment will allow analysts to do their jobs more efficiently and will empower them to lead the way in GEOINT-sharing capabilities with NGA’s partners. The Office of Global Navigation pilots will start to realize the day-in-the-life scenario described above, bringing NGA analysts and their partners closer to “analytical nirvana.” P

MARK MUNSELL

is the Technical Executive for the Office of Global Navigation, where he works on transformational issues and facilitates technology insertion for the Aeronautical and Maritime Domains.



OUR HERITAGE

GEOINT Foundations Establish Tradecraft for the Ages

BY DR. GARY E. WEIR

Shortly after the Great War of 1914–1918, a midshipman at the U.S. Naval Academy made a startling discovery on a naval summer cruise. He observed that the primary chart upon which the ship’s navigator relied dated to 1839. This seemed remarkable for a number of reasons. First, he discovered the high quality of early 19th century surveying and mapmaking and the reliability of the foundation data gathered over 80 years earlier. In addition, the chart formed part of a collection that emerged from the U.S. Exploring Expedition that circumnavigated the globe and diverted to such places as Antarctica between 1838 and 1842. This very successful venture marked the first time the young United States of America engaged in exploration far from its own shores. Not too many years ago, the Smithsonian Institution honored the expedition with an exhibit entitled “The Magnificent Voyagers.” Finally, the discovery seemed even more remarkable and the episode more ironic to the midshipman because Navy Lt. Charles Wilkes, commander of the U.S. Exploring Expedition, prepared the chart. As it happened, the midshipman recognized Wilkes as his great-grandfather. As part of his professional naval education, this young officer discovered at sea the vital and eternal nature of the knowledge provided both by his family and the foundation tradecrafts.

In preparing the reports based on the collection compiled over four years at sea, the personnel of the U.S. Exploring Expedition employed the considerable treasure they brought back from their long journey. The six-ship squadron brought back to the United States 280 island surveys; 180 charts, maps and surveys of the Oregon Territory coastline extending for 800 miles; and 1,500 miles worth of similar data for the Antarctic coast. Their efforts actually validated Antarctica as the seventh continent. The expedition eventually supplied the infant Smithsonian with the beginning of its extraordinary natural history collections. Combining the expedition’s Oregon maps and charts with the 1842 Rocky Mountain work of Capt. John Frémont soon enabled the United States to create a geodetic base for the territory between the Mississippi River and the Pacific Ocean. Wilkes himself prepared observations based upon personally



The Space Shuttle Endeavour collects topographical data during the Shuttle Radar Topography Mission in February 2000.

gathered data for the expedition reports on the Earth’s magnetic field and its gravity.

Their effort to understand the Earth in these most basic and essential ways places Wilkes, his expedition staff, Frémont, and other determined explorers among the scientific parents of the National Imagery and Mapping Agency (NIMA) and NGA. The four years, the six wooden ships, and the foundation research of the U.S. Exploring Expedition clearly emerged from the same fundamental requirement that gave birth in our own time to the Defense Mapping Agency’s (DMA’s) Digital Terrain Elevation Data, or DTED®, mapping database that provides accuracy down to 300-foot intervals across a much greater expanse of geography.

While time moved on, the need for knowing the Earth in this way obviously did not change. Wilkes and his company desired to know our world more intimately and





Image courtesy of the U.S. Naval Historical Center

"Schooner Porpoise and Flying Fish in Heavy Seas" by Alfred T. Agate. The Porpoise was one of several ships of the U.S. Exploring Expedition.

pursued that goal with a single-minded drive that confirmed a new continent. In the same way, DMA continued to refine the precision of DTED® by using the additional data that came from photo analysis and mensuration to improve the accuracy of its products.

The U.S. Exploring Expedition wanted to visualize as much as possible and take those physical impressions back to the United States in data, charts and art. Knowing how the Earth actually looks can make all the difference to peace, war, prosperity and understanding. One of the most impressive images produced by the expedition shows Sugarloaf Mountain overlooking the harbor of Rio de Janeiro. Expedition member Navy Lt. John Dale composed a landscape demonstrating the beauty of the mountain and its surroundings that both pleased and strategically informed. Over a century later, DMA and the U.S. Army Topographic Engineering Center performed the same function for the participants at the Dayton Peace negotiations on Bosnia in 1995, using their foundation data to impel the required terrain visualizations and automated cartography to tailor maps and analyze the topography in a way that made negotiators more comfortable with their assumptions and decisions. Just as our predecessor agencies did, NGA now provides this service daily in the form of geospatial intelligence to the warfighter and to allies in need of support due to natural disasters or external aggression.

In 1999, three years after DMA, the National Photographic Interpretation Center and other organizations combined to form NIMA, which became NGA, the agency went on an exploring voyage of its own with NASA. NIMA used the space shuttle Endeavor to dramatically improve DTED® by exploiting the radar interferometry techniques developed at the Jet Propulsion Laboratory in Pasadena, Calif. For 222.4 hours in February 2000, the Shuttle Radar Topography Mission, or SRTM, successfully surveyed 80 percent of the Earth's surface and 95 percent of its populated areas. The improved DTED® contributed incomparable accuracy to everything from geophysics to earthquake research to the best location for cell phone towers to missile targeting. This voyage did not involve a wooden ship under sail, and its techniques would have astonished Charles Wilkes, but he would have understood the goals and the importance of the data and the final products to both commerce and the national defense.

The best foundation activity lasts forever. It informs currently and provides the basis for an ever-deeper understanding and a platform upon which to build. It never grows old or irrelevant. The need for SRTM data and DTED® products and the importance of World Geodetic System 84 and Earth Gravitational Model 08, which NGA recently made available to the public, testifies to the constant relevance of foundation data and tradecraft. In 1943, during the island-hopping campaign against Japan in World War II, the Allied staff planning the landing on the island of Tarawa resorted to using a chart composed by the U.S. Exploring Expedition from the foundation knowledge the expedition had gathered in the 1840s. Having used techniques that stood the test of time, Charles Wilkes once again stepped forward in an essential way, this time to help American forces subdue the Japanese in a difficult campaign. NGA foundation professionals, past and present, regularly follow in the footsteps of Wilkes and his Magnificent Voyagers. ▢

DR. GARY E. WEIR
is the NGA Historian.



NEW CAMPUS EAST

Time-Dominant Operations Center Will Maintain Vigilance

BY GLENN FORINASH

Editor's Note: The Pathfinder and the New Campus East Advocacy effort invited Glenn Forinash of the Time-Dominant Operations Center to contribute this article.

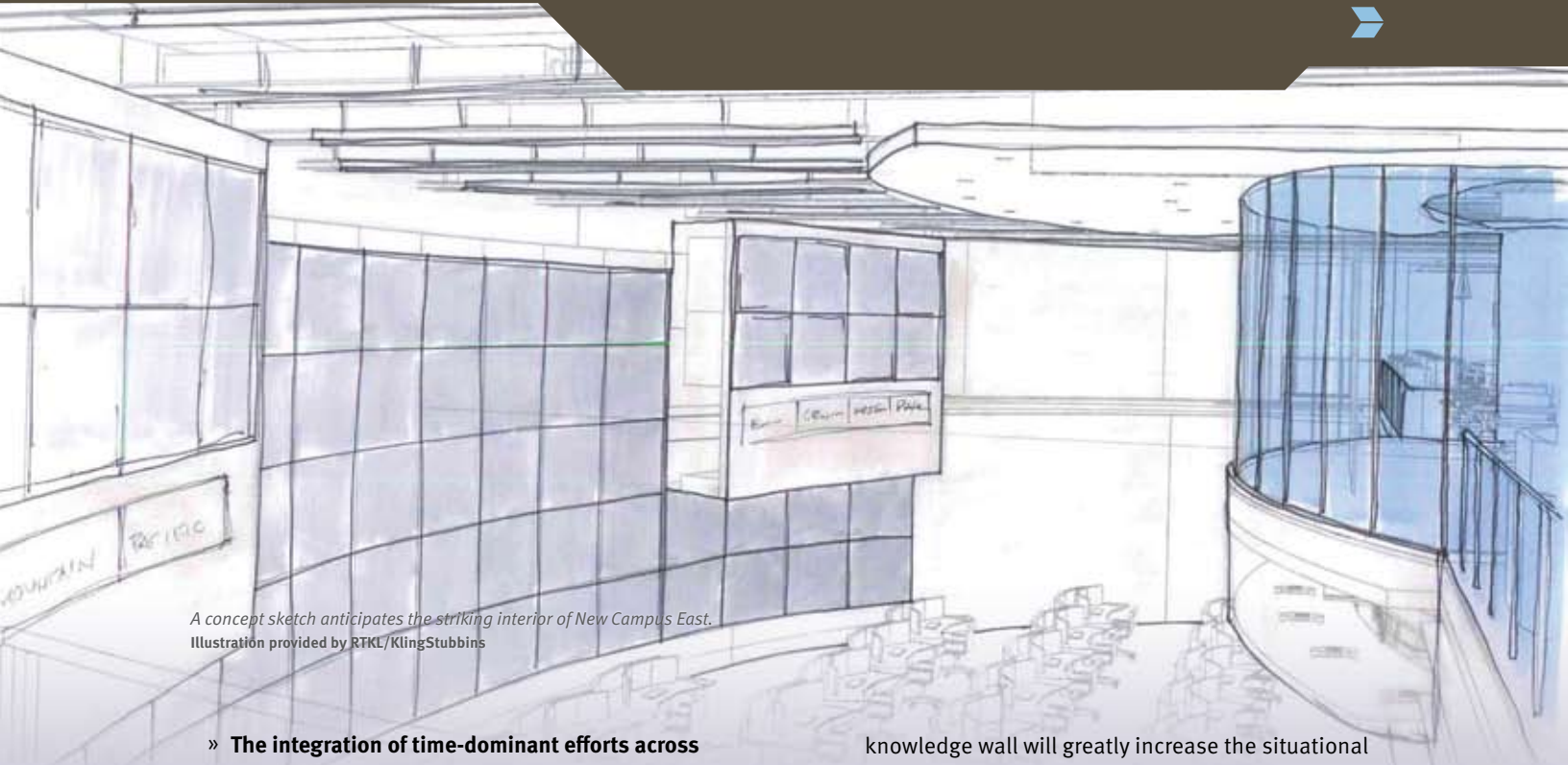
The National System for Geospatial Intelligence (NSG) Strategic Concept of Operations for 2015 lays out an expectation that Department of Defense (DOD) and Intelligence Community (IC) customers will require immediate geospatial intelligence (GEOINT) with increasing urgency. In anticipation of shortening timelines, in 2007 NGA established the Office of Time Dominant Operations, which provides a persistent stream of situational awareness data to its operations directors, analysts and customers across the NSG. The standup of the office and the implementation of the agency's own Time-Dominant Operations Center (TDOC) concept of operations synchronized time-dominant entities and provided a single NGA voice to its broad customer base. The New Campus East (NCE) TDOC will form the fulcrum of NGA's time-dominant support.

NGA units involved in time-dominant operations currently reside in a number of locations across the United States. The NCE TDOC will consolidate NGA's geographically and functionally dispersed time-dominant operations on the East Coast within a single, integrated center to enhance internal collaboration and the quality and timeliness of its GEOINT. TDOC analysts will have ready access to information technology support, and NGA leadership will have easy access to operational information and personnel. A similar plan to align agency time-dominant units in St. Louis, Mo., is also in work. The multidirectorate entity in St. Louis will be operational prior to the stand up of the NCE TDOC and will be critical in providing continuity of time-dominant operations during the relocation of units to the NCE.

The integrated NCE TDOC design adheres to four key concepts to better serve IC and DOD customers:



New Campus East will consolidate NGA's East Coast operations.
Illustration provided by RTKL/KlingStubbins



A concept sketch anticipates the striking interior of New Campus East. Illustration provided by RTKL/KlingStubbins

- » **The integration of time-dominant efforts across components** will be managed by NGA operations directors (ODs) who will synchronize efforts and marshal resources across NGA to respond to customers' needs. The ODs will continue to serve as a focal point for NGA customers requesting time-dominant support. The ODs will maintain their interaction with watches and operations centers across the IC, DOD and foreign partner organizations to ensure that NGA's time-dominant intelligence efforts are aligned with customers' priorities and information needs.
- » **The development of tradecraft and training for TDOC professionals** will continue to enrich the field of time-dominant operations. NGA's current training and certification programs for ODs ensure that they are able to fully represent and leverage NGA capabilities and respond thoroughly and consistently to customers' requirements. A training program for all NGA professionals performing elements of the time-dominant mission is currently in development and will carry forward to the NCE environment.
- » **The insertion of already evaluated communications and technology** to enable operations will facilitate persistent collaboration and situational awareness among IC sites and mission partners. The increased situational awareness and collaboration capabilities will enhance the quality and timeliness of NGA's GEOINT. Information technology resources will display all pertinent information needed by TDOC personnel, assisting them in maintaining analytic focus. The ability to display large amounts of information on NCE TDOC's newly engineered

knowledge wall will greatly increase the situational awareness of the ODs and TDOC components. Web-based geospatial visualization tools will package large volumes of data, and security technology will provide new means for disseminating intelligence information across multiple security domains.

- » **The improvement of the facilities** at NCE TDOC will synchronize time-dominant activities and help provide the best possible GEOINT to customers. Time-dominant analysts' ability to reach the broader NSG elements will be enhanced. Subject matter experts in many cases will reside in close physical proximity, providing greater access to the deep analytic capability found in NGA's functional and regional offices. NGA and the NCE professional staff have ensured that time-dominant operations will be conducted in an environment that allows persistent collaboration and guarantees multiple-security level access and seamless system interoperability.

NGA's critical contribution to the time-dominant mission will continue to grow as the demand from the agency's customers for timely and relevant GEOINT increases. The NCE TDOC will greatly enhance the information superiority and technological advantages essential to providing influential time-dominant GEOINT and warning of imminent threats. P

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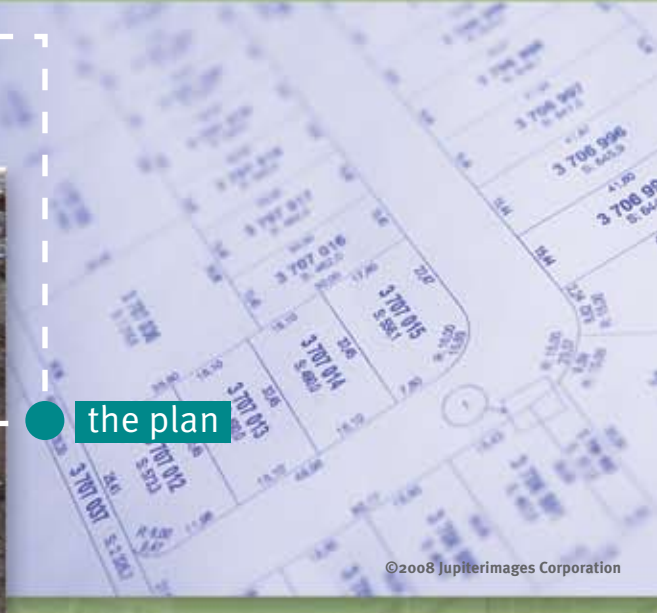
is an Operations Director in the Office of Time-Dominant Operations.



NCE PROGRESS



the groundbreaking



the plan



on schedule



the steel signing



the final rendering



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