

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

PATHFINDER

The Geospatial Intelligence Magazine

SEPTEMBER / OCTOBER 2005

NGA Makes the Difference

HURRICANES and TECHNOLOGY CHALLENGES

>> GETTING IT TOGETHER, BY U.S. REP. PETE HOEKSTRA

>> TECHNOLOGY CHALLENGES IN A NEW WORLD

>> GETTING TECHNOLOGY TO THE WARFIGHTER



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PATHFINDER
September/October 2005
Vol. 3, No. 5

ON THE COVER

NGA made available the first cloud-free satellite image of downtown New Orleans from a US commercial satellite to government agencies and first responders. NGA also provided on-the-spot analysis like this photograph of New Orleans and damage assessment graphic. Cover design by Leon Samuels.

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.

Published by the National Geospatial-Intelligence Agency

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Hurricanes and Technology Challenges

Letter to our Readers

Hurricanes Katrina and Rita were not on the horizon when we began this issue on NGA's technology challenges. So, it is appropriate that we highlight the contribution made by NGA members before, during and after these hurricanes. Both our technical and analytical expertise enabled us in our support to those affected by these tragic events. As the Director states in his column, because of the hurricanes, "NGA's technological capabilities have been brought to bear as never before." He also notes that support our Agency provided clearly illustrates our ability to "Know the Earth and Show the Way." Both ideas are exemplified in the article we have added to this issue on NGA's hurricane response.

This interplay between people and technology continues, as we look at technology challenges facing NGA from the vantage point of our many contributors and end users. The fourth issue in our series on how NGA is making an essential difference begins with an article by the Honorable Pete Hoekstra, Chairman of the House Permanent Committee on Intelligence. "The Agency is now fulfilling its promise of closer integration between mapping and imagery analysis," he says.

In my article, I introduce a variety of technology challenges—from a near-term need for on-demand access to geospatial intelligence (GEOINT) to the long-term imperative of developing new and unconventional sources and processing methods. In an era of global persistent surveillance, analysts will require new strategies and architecture to rapidly exploit increases in data flow and data types.

In "Getting Technology to the Warfighter," NGA's Deputy Military Executive, Ed Mornston, explains how close interaction with warfighters is necessary to keep the technology relevant in a continually changing context. "Getting high-end, dense GEOINT into the hands of 'disadvantaged users' who are well forward on the battlefield is the issue that many commanders feel is the next big step in GEOINT support to operations," he says.

Other articles discuss eliminating barriers in the National System for GEOINT, NGA's strategy for inserting technology rapidly, and how NGA improvements to JPEG2000 are revolutionizing the processing of imagery. Our Historian looks at Vietnam War support, which foreshadowed today's collaboration within NGA and across the Intelligence Community. "21st Century" discusses advanced geospatial intelligence, and our "Industry" column looks at small companies with projects that promise to have a big impact. In "Partnerships," we feature our collaboration with the Defense Advanced Research Projects Agency on "hard problems."

In the next Pathfinder, we'll look at how NGA is making a difference in the international community, using GEOINT to support U.S. leadership abroad, working with foreign partners to enhance the value of GEOINT and helping many nations improve their capabilities.



Mark Schultz
Director, Office of Corporate Relations

Director, Office of Corporate Relations



On My Mind

NGA Responds to Gulf Coast Catastrophe

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

Our nation is facing the tragic aftermath of the worst natural disaster in our history. Hurricanes Katrina and Rita have devastated the Gulf Coast area of the United States, from Texas to Alabama. We extend our deepest sympathies to all those affected by this terrible, unprecedented catastrophe.

NGA is doing everything we can to support ongoing relief and recovery operations. Our Agency's efforts began even before Hurricane Katrina struck. On Friday, Aug. 26, NGA forwarded 100 graphics depicting the locations of key infrastructures—hospitals, police stations, highways, schools, etc.—for the counties in the path of Hurricane Katrina. Those graphics provided local and state government agencies with a common operational picture of key facilities.

Since the hurricanes struck, NGA personnel:


- Analyzed pre-hurricane and post-hurricane data to help develop damage assessments of the affected region, including critical infrastructure and long-range assessments of the petroleum industry.
- Provided the Federal Emergency Management Agency the first cloud-free satellite image of downtown New Orleans from a U.S. commercial satellite. Then, NGA personnel, working closely with commercial vendors, provided all our unclassified imagery holdings to the general public through the World Wide Web.
- Deployed to the impacted region to provide on-the-spot support to U.S. government agencies also deployed to the region. They exploited the ability to "reach back" to NGA for additional support.
- Took over operations from the damaged U.S. Coast Guard facility

and transmitted electronic Notice to Mariners updates along with weather information to mariners in the Gulf of Mexico.

- Developed an integrated strategy to task and acquire imagery from a variety of platforms and sensors. This provided the best information for analysis and public discussion.

Over the past several weeks, NGA's technological capabilities have been brought to bear as never before. Our response to these hurricanes clearly illuminated our technical know-how. Equally impressive has been NGA's analytical contribution to the relief efforts. NGA analysts have worked closely with the Federal Relief Community to provide round-the-clock support. NGA personnel created and provided tailored and specific analytic products that enabled national and operational situational awareness, assessment, planning and execution. Rapid decision making was the outcome during response and recovery. And, new customers who now appreciate the power of geospatial intelligence were established.

People helping people, whether technical, analytical or support, is what distinguishes NGA as we carry out our mission to "Know the Earth and Show the Way."


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

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Appreciation for NGA's Contribution

NGA's response to the historic natural disaster on the Gulf Coast has prompted compliments from across the government. NGA Director retired Air Force Lt. Gen. James R. Clapper Jr. shared one of these testimonies in an e-mail to the workforce. It came from the Deputy Homeland Security Advisor to the President, Michael P. Jackson, during a cabinet-level meeting to prepare for Hurricane Rita.

Speaking to the Director, the Deputy Homeland Security Advisor remarked, "I want you and the other conferees to know how much we appreciate what NGA is doing."

He added: "I am an avid user of your products. The imagery and geospatial depictions of the damage and recovery efforts are absolutely invaluable. If any of the departments are not aware of NGA's capabilities and responsiveness, you should get familiar. Your work is fantastic."

NGA Hurricane Response SETS PRECEDENT

By Lynne Puetz, Director, Office of Americas

The recent support NGA has provided to our nation in the wake of two historic hurricanes has been unprecedented and viewed by many customers as “setting the standard

for future geospatial-intelligence (GEO-INT) responses to worldwide issues.”

NGA supported scores of customers in preparing for and responding to Hurricanes Katrina and Rita. The broad level of support included identifying key infrastructure, accurately locating



citizens in need, conducting damage assessments, monitoring levee stability, issuing navigational advisories and many other actions.

NGA was on the ground at every key customer location providing critical information to first responders, national agencies and the Department of Defense. We organized across the Agency to provide reach-back for customer needs 24 hours a day.

Operations began before Katrina's waves came ashore on the Gulf Coast Aug. 29. Three days earlier, analysts had forwarded more than 100 graphics to crisis centers pre-positioned to respond to the aftermath of the disaster. These graphics depicted the location of key infrastructures—airports, hospitals, police and fire stations, emergency operations centers,

hazardous material locations, highways and schools.

NGA had been tracking the hurricane before it brushed southern Florida on its way to the Gulf of Mexico. As Katrina veered toward the Gulf Coast, analysts deployed ahead of the hurricane with regional teams of the Federal Emergency Management Agency (FEMA) to be available immediately. These analysts had full access to NGA imagery, databases and products and the ability to reach back for support from the greater NGA community through the establishment of a Crisis Action Team in Bethesda, Md.

Members of a military support team begin relief operations near New Orleans, La. NGA also sent several analysts to the disaster areas to assist with relief and recovery efforts.





NGA deployed two of its Mobile Integrated Geospatial-Intelligence Systems (MIGS) to provide on-the-spot analysis of the hurricanes. The MIGS can be set up and operational within a few hours after reaching its destination.

First Responders a Priority

The first thing NGA analysts did after the hurricane passed over the Gulf Coast was to task new reconnaissance so they could understand the extent of the damage. Collecting and analyzing imagery from National Technical Means (NTM), commercial providers and available airborne assets across the region, they provided information to help decision-makers better focus available resources to critical areas of concern.

It became immediately apparent that the disaster was worse than anything we had seen on U.S. soil. The aftermath of the combination of storm surge, wind, rain and ongoing flooding was horrific. The damaged area was larger than Great Britain.

Analysts next turned their attention to 30 counties and parishes, designated by the FEMA, in the storm path. Analysts examined the imagery closely for stranded people, missing houses, flooding and other signs of local emergencies. Analysts in the Homeland Security Division determined that New Orleans and Hancock County, Miss., stood out as the hardest hit,

but they also focused on damage to key petroleum pipelines, refineries, offshore drilling rigs and power plants throughout the region.

To answer immediate questions posed by first responders, analysts focused on outlining flood areas and identifying evacuation routes. The volume of data coming from all available sources allowed NGA analysts to obtain the necessary information to assist our customers in planning each step in the recovery process. In all, Homeland Security analysts looked at 167 kinds of data that our Agency collects for its Homeland Security Infrastructure Program. Primarily, they compared stored data with current imagery and updated the current situation with each new source. We provided copies of this updated infrastructure program data to coordinators of state geographic information systems, who distributed it to state and local entities.

Immediately after the hurricane, our Commonwealth partners offered their

Photo by Phil McCabe

assistance. Four imagery analysts arrived from Australia, Canada and Great Britain to work side by side in our footprint. Their assistance proved invaluable to our support efforts.

Analysts also worked closely with their co-workers in the Source Operations and Management Directorate to find all sources available to improve analysis and production capabilities. When they look at a problem for a customer, they try to evaluate information from multiple sources to get the best answer. Sometimes a tip-off from one sensor will lead them to task another to provide better information to solve a customer's requirement.

Common Operational Picture

One of the critical roles NGA played during the first few days of the search-and-recovery phase was assisting the FEMA Urban Search and Rescue teams by providing a range of products to assist local police departments, fire departments and rescue units in locating stranded people or conducting casualty operations. Our forward-deployed analysts recorded locations of survivors for follow-on rescue

activities and identified potential staging areas. This capability allowed a real-time geospatial common operational picture, shared by a variety of units in the field who desperately needed our expertise to meet their mission needs.

Meanwhile, analysts in Bethesda looked at the levee breaks to determine their location and length. Next, they examined the entire levee to check for additional breaks and danger points. As a result, they detected a potential new breach in St. Bernard Parish, east of New Orleans, which the Army Corps of Engineers was able to fix before it became more serious, averting more potential lives lost and property damage.

Besides supporting FEMA, NGA supported the U.S. Northern Command (NORTHCOM), the lead military unit, and 80 other customers. NGA increased its liaison team at NORTHCOM headquarters, assigned analysts to Camp Shelby, Miss. to support Joint Task Force Katrina, and provided additional support to the 82nd Airborne Division, 1st Cavalry Division, and 2nd Marine Expeditionary Force.

GEOINT products were used by several members of federal, state, and local governments, and first responders.



Photo by Phil McCabe

Deployed NGA personnel supported the 82nd Airborne in search and rescue operations and Joint Task Force Katrina with data on concentrations of displaced civilians and casualties requiring evacuation.

In some cases, we helped find places to relocate these displaced persons. We identified a site in Louisiana—Camp Minden—that would be suitable for a tent city of 15,000 people. NGA also provided information to helicopter crews looking for hospitals that could take survivors, providing geospatial awareness first responders needed to save lives.

Support on the Ground

NGA analysts on the ground worked from two mobile support stations called Mobile Integrated Geospatial-Intelligence Systems (MIGS) or “NGA in a Humvee.” Deployed during the invasion of Iraq, these units operate on their own power, downloading imagery and graphics by satellite and providing workstations for on-the-spot analysis.

Before arriving on the Gulf Coast, the deployed analysts had collected all the map, infrastructure and imagery data available for the region and downloaded it into laptops.

Photos like the one below, along with NGA products, gave government leaders and first responders a detailed and accurate damage assessment.



Photo courtesy of the Department of the Army.

NGA also deployed a Remote Replication System, capable of printing out digital files and hardcopy input as paper maps, to meet the requirements of officials involved on site in the recovery or in operational planning. For the military, RRS personnel downloaded copies of digital products directly to their “thumb drives.”

NGA officials used a contract clause to make commercial imagery and geospatial data available to state and local responders. In short, the Agency purchased all the imagery collected by commercial vendors. The Crisis Action Team immediately made this imagery available to the federal government, state and local governments, and first responders through NGA’s World Wide Web services.

Extraordinary Navigational Guidance

Besides providing geospatial analysis, NGA broadcast navigation safety messages for the U.S. Coast Guard. Due to damage at District 8 Headquarters in New Orleans, the Coast Guard had lost the ability to provide communications to their assigned area, the Caribbean Sea. NGA assumed that responsibility for the Coast Guard.

The World Wide Navigational Warning Service in NGA’s Global Navigation Office provided essential information about port closures and waterway conditions, such as blocked channels, oil leakage, damaged oil platforms and grounded tank ships. The Service also transmitted National Weather Service messages to mariners at sea, covering gaps in service due to local outages. NGA has continued to broadcast operational warnings to customers, including the U.S. Navy and Merchant Marine, while Coast Guard systems are fully restored.

The backup NGA provided was unprecedented, according to the Chief of our Maritime Division, Navy Capt. Paul Heim.



Photo by Rich Benjamin

NGA analysts received many inquiries from citizens wanting to know the status of their homes and property. The NGA Website provided an accurate and efficient way for them to access this information.

"We normally broadcast warnings for the Atlantic and Pacific, a function that dates back to the turn of the century," Captain Heim said. "But because of Katrina, we automatically kicked in to augment and replace the Coast Guard capability."

The Global Navigation Office also monitored airfields within the affected area as well as those in the surrounding area designated to support relief efforts. Aeronautical analysts provided assessments of conditions at the airfields and provided Notices to Airmen (NOTAMs) and aeronautical charts to military units that deployed on short notice.

Role in Recovery

As most of the Gulf Coast from Alabama to Texas recovers from Hurricanes Katrina and Rita, NGA continues to play an important role. For example, the Office of Americas has been participating in the

analysis of all the affected industries in terms of environmental cleanups that are needed.

The Agency has been given the authority to reach across federal, state and local governments to help people deal with the disaster. We are providing direct support to many organizations, including the White House, Corps of Engineers, Environmental Protection Agency, FEMA, NORTHCOM and various other military customers.

NGA's contributions are the result of a phenomenal team effort from individuals across the entire organization. To quote the Director, "Many, many people from across NGA have pitched in and contributed to this effort. You should know that our work has been noticed and appreciated—from the President to first responder, and all ranks in between."

At the same time, NGA continues preparing for disasters that will occur in the future. In the wake of Hurricanes Katrina and Rita, senior leaders are conducting a thorough assessment of the Agency's response. As part of this effort, employees had been asked through NGA Web pages to provide feedback for improvements with the goal of improving crisis and disaster response in the future. Employees across the Agency have also responded generously as individuals to victims of

the two disasters, helping out in countless ways, such as contributing to a special appeal of the Combined Federal Campaign.

With all the natural devastation our country has been exposed to due to the last two major hurricanes, and the outcry of need from our federal and military customers, NGA has reached a new level of providing GEOINT—a baseline we will build on to continue our transformation for the future.

Coalition Partners Provide Timely Expertise

By Jessica Rasco

Analysts from the Commonwealth deployed to NGA Headquarters to augment the Homeland Security Division in responding to Hurricanes Katrina and Rita. These individuals provided significant and sustained support to the response and recovery operations of the U.S. government.

The Canadian Forces Joint Intelligence Center provided imagery expertise that was invaluable in assessing the impact of Katrina to coastal petroleum refinery operations. The requested data analysis enabled mission planners to assess maritime navigation hazards as they prepared to conduct humanitarian operations along coastal Mississippi and Alabama. Canada also provided a functional analysis of critical petroleum pipelines south of New Orleans.

Analysts also deployed from the Joint Air Reconnaissance Intelligence Centre in the United Kingdom. Their contributions included daily analyses of the flooding in New Orleans and vicinity. Their assessments of the receding floodwaters were provided to the federal response community and briefed to the highest levels of the U.S. government. The British analysts also assessed damage and impact to southern Louisiana's transportation network.

The Australian Defence Imagery and Geospatial Organisation (DGIO) monitored and assessed flood damage to southern Alabama. NGA and the DGIO also worked together in the aftermath of the Pacific tsunami, assessing infrastructure and industries in Indonesia.



Getting It Together

By the Honorable Pete Hoekstra, Chairman, House Permanent Select Committee on Intelligence

Encomiums are due the National Geospatial-Intelligence Agency and the talented men and women who not only are the muscle of the Agency, but its soul. The Agency is now fulfilling its promise of closer integration between mapping and imagery analysis. This is most gratifying to the Congress which, despite some healthy questions from time to time, has supported the Agency fully from its inception through what we might term its “adolescent phase.” Today, the concept of one, integrated Agency has come to feel quite natural, but it was not always so. Indeed, only last spring was the Agency able to announce that its Office of Strategic Transformation was closing, signaling a final shift from the planning to the doing. The “doing” part may prove to be the most challenging aspect for NGA, and the Congress will be keeping a watchful eye on the pace and scope of these efforts.


While all the signs augured for a happy union, arranging that marriage was not easy. It took people of clear vision to see that, despite the obstacles to be overcome, the integration would prove of inestimable value to our nation. In a word, it took leadership, a commodity in sometime short supply. It also took open-mindedness and a dedication to the mission on the part of the workforce. There was, first and foremost, a cultural divide that had to be bridged.

Secrecy was the imagery analysis tradition, inherited from the National Photographic Interpretation Center. The watchword was “need to know” and, above all, “protection of sources and methods.” Imagery came initially from secret spy planes—the U2 and, later, the SR-71 “blackbird.” Their

very existence, much less their details were closely held in special compartments, as was the derived imagery and imagery intelligence. Later, satellites and satellite cameras were accorded the same compartmented treatment. Contrast this with the world of maps and charts, where the sources are openly credited, their *bona fides* available for inspection, to reinforce the authoritative nature of the products. Sadly, it took the tragedy of Sept. 11, 2001 to reset the balance between secrecy and sharing.

Technology jarred culture when, in the middle of the last century, airborne and space-borne imagery became the basis for modern mapping, charting and geodesy. Observe that an anagram of “geodesy” is “God’s eye.” It was the God’s eye view of overhead imagery and its metric accuracy that gave a tremendous boost to the world of mapping. Before overhead imagery, map inputs were the result of ground survey—chaining distances, turning angles, compass headings, triangulation and metes and bounds. As NGA’s history points out, the U.S. geospatial intelligence effort began in 1803 when President Thomas Jefferson sent the Army’s Lewis and Clark expedition to explore and map the recently acquired Louisiana Territory. The Army, assisted by its contract civilian scientists, supported the country’s westward expansion in that era, just as the Agency’s geospatial products support national goals today.

Another cultural chasm to be bridged was the distinction between being an intelligence agency vice a part of a military service, later a defense agency dedicated to supporting the military services. Employees of a civil agency, the



National Photographic Interpretation Center, ultimately had either to transfer to the Department of Defense or give up their career specialty and return to the Central Intelligence Agency. Many of the most talented, the most dedicated officers, weathered the change. They adapted and, while nostalgic at times, shifted their allegiance to the new organization where they helped shape today's hybrid culture, which incorporates the "best in breed."

Even the defense mapping personnel that NGA inherited comprised not a single workforce but several, each with its own work rules, pay scales, legal status and subcultures. Here, too, over time the importance of the mission, coupled with firm leadership and employee dedication, has eroded much of the distinction. Now, NGA is well on the way to having one harmonious workforce—a symphony rather than a cacophony.

The workforce integration required drastic changes to the information infrastructure. Computer networks that previously operated distinct from one another and at different security levels had to be rationalized and interoperability achieved. An infrastructure that supported both had to be put in place. Prior to the merger, each of the major constituents—the Defense Mapping Agency and the National Photographic Interpretation Center—had computerized important parts of their respective operations. A needed upgrade of the original softcopy image-exploitation capability provided the new Agency with the opportunity to include in it a geospatial toolset, anticipating the integration of the imagery analysis and mapping disciplines.

In retrospect the marriage of imagery analysis and mapping was inevitable when man took to the air with a camera and gave mapmakers an alternative feedstock to ground surveys. But, another propitious omen was the development of

"softcopy," especially when commercial software offerings integrated vector and raster manipulation and display and "GIS" became the "best of breed." As a testament to the Agency's digital reach, last spring a guided missile cruiser, the USS Cape St. George (CG 71) sallied from its home port in Norfolk, Va., without paper charts on the bridge. Instead, it used an electronic system with the Agency's Digital Nautical Chart (DNC®) as its primary navigational system.

The Global Positioning System (GPS), used by the USS Cape St. George—as well as by every other military ship and plane, civil aviation, commercial maritime vessel, and many private automobiles and boats—has allowed geospatial products to enable or improve nearly every military operation. GPS-guided weaponry, such as the Joint Direct Attack Munitions, dramatically changed the nature of modern warfare, reducing by orders of magnitude the number of munitions and sorties necessary to destroy a target and reducing collateral damage, as well. More important, it has saved countless U.S. service persons' lives by adapting a "strategic" weapon to perform close air support. The men and women of NGA, justifiably proud of this contribution, daily earn the gratitude of every U.S. warrior and their kin.

Not only does GPS add value to NGA's products, the men and women of the NGA have contributed materially to improving the accuracy of GPS and all of its applications. They run a set of tracking stations which more accurately track the GPS satellites inasmuch as the antenna of each tracking station is, itself, more precisely located. Indeed, it is estimated that NGA knows precisely the distance and direction from their antenna feeds to the center of the Earth. And, the accuracy is kept up using a model that accounts for all the vagaries of time and tide, even continental drift.

NGA inherited limited acquisition, or program management, capability from its constituent parts, the Defense Mapping Agency and the National Photographic Interpretation Center. In each case, previous upgrades to the workhorse information systems of its forebears were developed by the National Reconnaissance Office and/or the Defense Mapping Agency. This lack of native acquisition capability was particularly worrisome—both to the Director of Central Intelligence and to the Congress—because the Agency had to prepare itself for two new generations of imagery satellites. These would overtax the Agency's capacity and prevent the U.S. from realizing the full value of those satellite investments.

In the event (Congressional urging), firm leadership and a dedicated workforce prevailed. NGA now has a strong acquisition corps, of which it can be proud. Indeed, the Agency is embarked on an unparalleled modernization program, GeoScout, which upgrades further its enterprise-level information systems. GeoScout will transform the Agency's people, processes and technology. It involves improving corporate operations and staff knowledge, skills and abilities, and streamlining the way the personnel do their jobs, tradecraft and business practices. To keep it that way, GeoScout also involves rapid-technology insertion and upgrading.

Today, computer systems have a short half-life. They come and go several times during the tenure of career employees. And, organizations reconfigure and missions evolve. The workforce is subjected to continual change and we expect it to provide the needed stability. NGA, with hearty Congressional endorsement, has invested in continuous training and retraining, without which employee options would be severely restricted and their long-term contributions reduced. Wise employees take full advantage of these opportunities for both classroom education and diverse

on-the-job experiences. As the mapping and imagery disciplines have converged, the shrewd employees are the "switch hitters"—those who have worked in, and mastered, both crafts. Workforce planning, retention and continuous improvement are especially important as the Agency tries to iron out the results of an earlier downsizing with an accelerated hiring rate in the wake of Sept. 11, 2001.

Among the most visible personnel of NGA are those engaged in consumer outreach—ship riders, those assigned to the military commands, and those who go forward as and when the need arises. They all get uniformly high marks and their Agency should value this experience. As junior officers who have taken advantage of this opportunity rise to senior leadership positions they will perform the better for it. There is really no substitute for having lived with those who use your products.

Users of the Agency's products have traditionally been the U.S. military and the foreign intelligence apparatus. Increasingly important, now and for the foreseeable future, are the needs of homeland security, which include domestic as well as foreign needs, civil support as well as military. Of course, NGA has always provided domestic support for national-security events and civil support in the event of major disasters. In fact, as this is being written, NGA is supporting relief efforts for Hurricane Katrina by providing imagery and geospatial products and support for areas in and around the cities of New Orleans, Mobile, Ala. and Gulfport and Biloxi, Miss.

The nation owes a debt of gratitude to the loyal men and women of NGA. This is an Agency that is now "getting it together." Of course, NGA is not yet perfect—no organization ever is—so its officer, rank and file and leadership, must continue its deftness in meeting the unknowns of tomorrow while enabling the national security today.

Technology Challenges in a New World

By Mark Schultz, Director, Office of Corporate Relations

The game has changed. It will continue to change. Combating terrorism, tracking the development and proliferation of weapons of mass destruction, protecting our homeland, and enabling the synthesis, interpretation, and visualization of information—all of this is dramatically increasing the fidelity and mix of content NGA must deliver. Intelligence problems have become globally diffused—challenging our reach. Targets are smaller, dynamic, and fleeting—challenging our omni-presence. The adversary is often a non-state actor without readily apparent facilities or easily observable signatures—complicating our search. And those we do know hide their equipment in urban environments, caves, and underground. They take increasing advantage of concealment and denial and deception—challenging our methods and means.

The playing field has shifted. It will continue to shift. The rate of change is increasing. It will accelerate as the world discovers the power of geospatial intelligence to inform information consumption and decision making. NGA support to those responding to Katrina demonstrated that power. Google Earth® and Microsoft Virtual Earth® and other capabilities like these, are driving the business of geospatial intelligence forward by opening a realm of technical possibilities.

The rule book has been rewritten. The World Wide Web, commercial and foreign imagery and now, geospatial visualization has shifted the symmetry. Adversaries can reach, understand and exploit information content easier than in the past. The previously hidden and hard to obtain is now available at the click of a mouse. Speed and

utility matter now more than ever before; and utility is only maintained by staying forever agile. National Security depends on the Nation's ability to make correct decisions faster than our adversaries. Geospatial Intelligence is a critical enabling capability toward that end. Therefore, the work and how we perform it must change at the speed of technology.

In response, NGA is looking out six hours, six days, six months, one year, three years, ten years, and twenty years. Through the employment of tools and technologies developed by industry and ourselves we are creating capabilities in near real-time as we respond to crisis demands from disaster recovery to terrorist localization. We are expanding our interface to our customers and the world through industrious arrangements with imagery and web service providers. And we are engaging the most progressive among us to remake our approach to technology insertion, advancing our capabilities on time cycles of months, not years.

More than On Demand Access to GEOINT

We set the bar high for ourselves. Operation Iraqi Freedom, the War on Terrorism, and Hurricane Katrina proved the power of GEOINT. Now we must serve it up with a capability equivalent to the strength of its content. Demand for our data, knowledge, and service has moved beyond the limitations of our web pages. Nothing short of a full web services capability will meet the need. We must take full advantage of our holdings, our portal and "killer app" like Palantira™. Our objective is to establish and continually mature an enterprise interface of loosely coupled and federated applications. This requires a fundamental

shift in our business approach and mission execution. We must migrate interoperability from the data level to the service level. Speed and agility matter. Speed and agility can be achieved not by creating the perfect data or remaking the data to meet the emerging need but by recombining data in new ways to achieve new results. That is done at the service application layer. It is enabled by inter-operable applications and technically smart analysts. Moreover, we can and must enable access to databases wherever they reside, to whoever needs them. Everything we do in this service domain must be extensible and scaleable, employing today's technology, not yesterday's. We will take advantage of our labs and usher in a renewed era of development that operationalizes new technology at the speed of the need, method or mode. All of this is possible and in reach. A first capability is achievable in six months and a full capability in two years. The end result will be an intuitive

Tracking the development and proliferation of weapons of mass destruction is one of the many global intelligence challenges facing NGA today.

and immediately adaptable web capability that enhances the power and utility of GEOINT by enabling real-time actionable intelligence.

It's Not Your Father's TPED

We must become more than a web service provider. We must move beyond our heritage approach. When collection assets were limited it made sense to make tasking job one. Then we only had to readout the imagery to get the intelligence correct. It made sense to tightly couple tasking, processing, exploitation, and dissemination (TPED) capability to a specific collection system. But no more.

Speed and agility matter. We can no longer rely on a single platform to deliver the intelligence necessary to meet the need. It is the complimentary nature of our entire sensor and platform suite that delivers sensor and platform suite is key. Conflation must occur at the point of optimization. Tipping

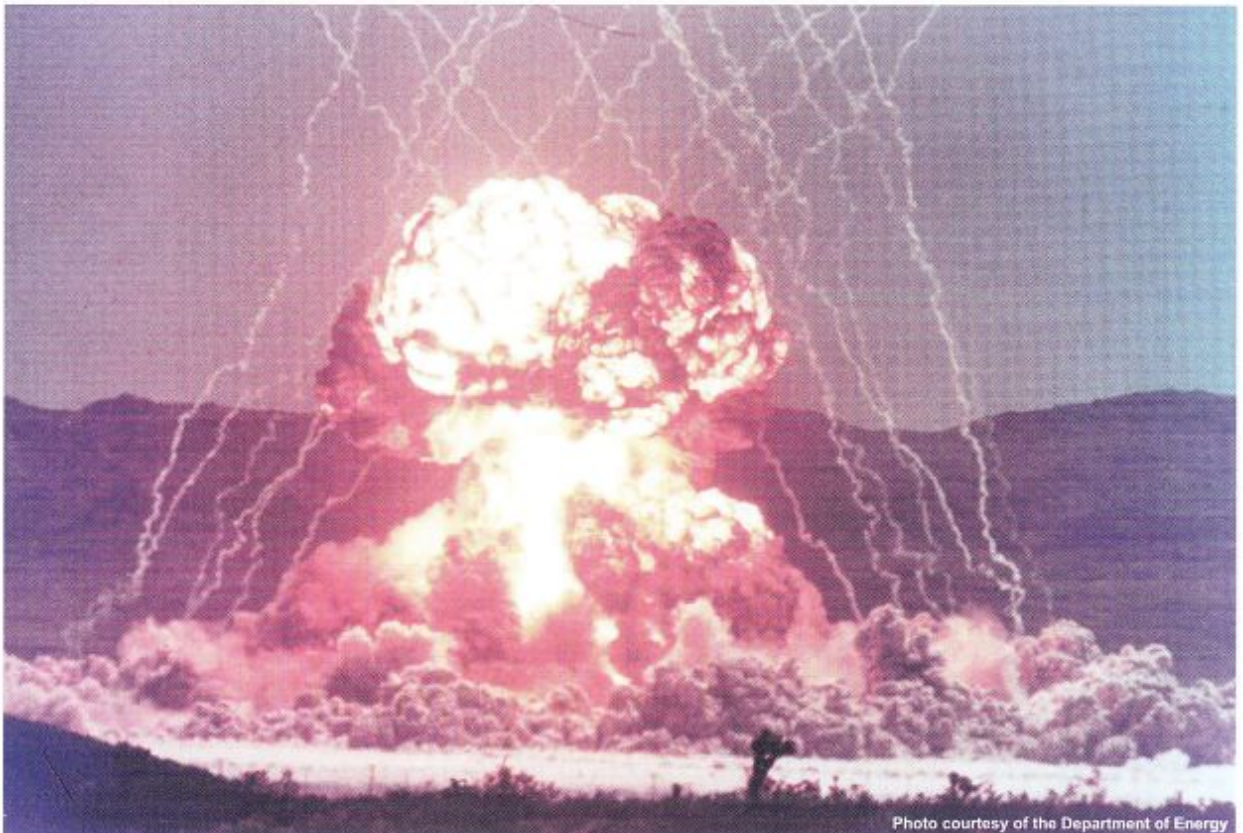


Photo courtesy of the Department of Energy

and cueing and informing must be temporally synchronized. So, when it comes to data and information generation, only a coverage, web enabled TPED architecture makes operational sense. There is nothing trivial about the challenge of converging ongoing programs into our GeoScout effort. It is focused in the area of our business that draws on our deepest scientific and mathematical expertise. It requires the most rigorous and often unique, technical solutions and, programmatic processes continue to impede end objectives. We must focus, critically focus, our effort toward moving the data and information generation sector of our business forward. And we must move it forward in a way that optimizes this technical domain. We must do this while enabling existing and emerging sensors to compliment each other in shorter and shorter conflation cycles.

Full stream processing is a key to our success. It will greatly improve speed and agility. And, it will require different relationships with our source providers. We will require upstream processing inserted at the point of optimization and for some functionality, that may be in the source providers' part of the image stream. We need today, and will require tomorrow, sensor-to-sensor cueing.

Looking down stream, where possible we must eliminate the need for analysis, enabling information flow directly from the sensor to the situational awareness screen or to the waiting application or to the Geospatial-Intelligence Knowledge Base (GKB) data layer. Speed matters, we must unburden the analyst from the routine of counting or extracting things that machines can handle. NGA's most critical asset—our talented analytical people, can then be redeployed to the difficult problems of the new game. It takes deep analytical expertise to know that one is watching a terrorist in a Predator

real-time streaming video and not some innocent civilian. We must provide our officers with the analytical time to build and maintain this expertise. And we must give them the tools to make such work efficient. Tools like data mining, Bayesian belief nets and other predictive analytical techniques will increase the speed, richness and completeness of our output.

Reaching Out — Well Beyond Conventional Methods & Means

Continually building the agility to respond in time, space, and reach is the focus of our technical and analytical challenge. Expanding our access to and employment of new sensors and platforms will continue to be foundational—first to agility and second to speed. It is the exploitation and conflation of complimentary source capabilities that will enable us to fill the voids created by the “new game.”

Increasingly, we are expanding our sensor, spectral, spatial, and temporal diversity. Agility enabling sources like multi-spectral, hyper-spectral, laser and video are being complimented by unconventional synthetic imagery. These advanced techniques enable multidimensional views and reveal indicators not normally apparent. Literal interpretation of source imagery is giving way to non-literal techniques and advanced methods. Advanced Geospatial Intelligence is bringing certainty to conclusions that in the past were only probable.

Multi-dimensional pattern recognition is emerging as multiple sources and advanced methods are applied to difficult problems. In time, these techniques will help the analyst anticipate action, bringing new problem solving input to the decision maker. The confirming value of imagery will be enhanced.

New sensors also improve speed and depth of holdings by enabling automatic change detection, automatic feature extraction,

and automatic tipping and cueing. These same sensors are filling data voids that in the past could not even be considered. The Shuttle Radar Topography Mission proved this approach. And there are new collection and processing techniques providing data volumes at rates not previously thought achievable. This pace of change will only accelerate.

Equally important to exploiting existing and emerging sensors and platforms is our ability to reach and exploit existing data sets. We must be able to pull these data sets in or reach out to them with distributed computing. Returning conflatable views and uses is our aim. Co-registration of data with data, data with imagery and imagery with imagery will continue to be a challenge as open source becomes an increasingly important contributor and as no-metric platforms continue to proliferate.

The long term utility of the GKB will be determined by its adaptability to emerging needs and data types. Data generation is expensive, and switching costs associated with database design must be eliminated. In a service approach to problem solving, data must be available when and where

it is needed. We must design our systems to protect our investment in data and to enable agility and speed.

And the Rest of the Story

First and foremost, meeting these challenges will require people, thinking and acting people. NGA's analysts have an immediate critical need for tools and capabilities. Enabling them will springboard their already strong advancement of GEOINT to meet the challenge of the new game. Developers, engineers and scientists have an immediate critical need for streamlined processes. Freeing them of process drag will enable the thinking time to achieve systems designed to change and greatly accelerate technology insertion.

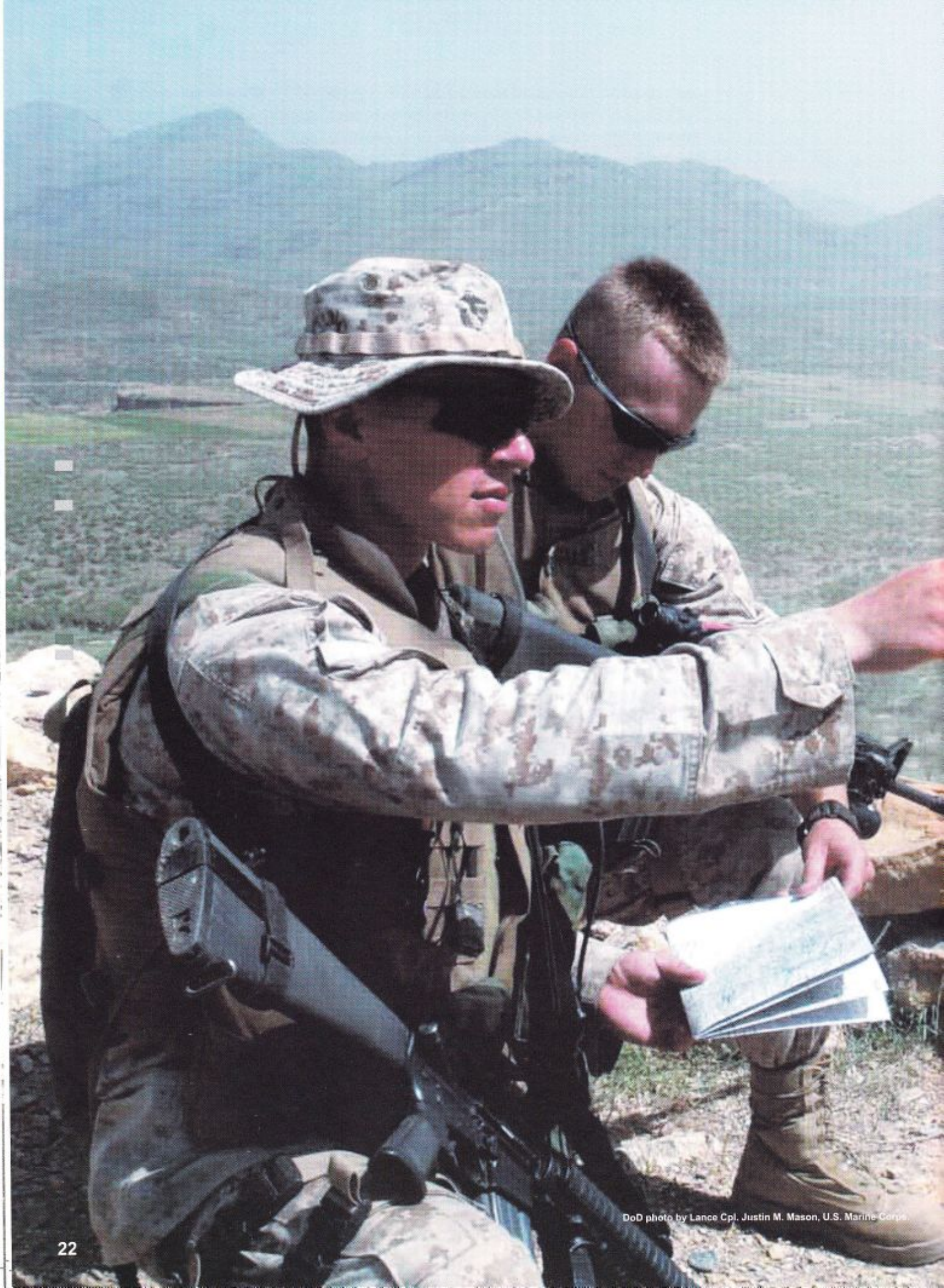
Even as this admittedly inadequate look at technical challenges is being drafted the game, playing field, and rule book are all changing. That rate of change will only accelerate. In the final analysis only the utility of our products and service will matter. And that utility will be built on the strength and depth of our science, our knowledge, and our information. Enabling ourselves to meet emerging needs on ever diminishing timelines is key.

NGA and USJFCOM to Form Partnership

The United States Joint Forces Command (USJFCOM) and NGA have established a partnership to develop Joint Force doctrine, training, and concepts to meet joint warfighter requirements for GEOINT support down to the lowest tactical level, i.e., to the "last tactical mile." This collaborative approach enables Services and commands to become connected to the National System for Geospatial Intelligence (NSG) and provides improved ways for military members to receive and utilize GEOINT.

The agreement is based on the Joint Geospatial Intelligence Activity (JGA), which is chartered to bring the military Services together to create joint requirements and solutions to enhance GEOINT support among national and tactical users.

USJFCOM is headquartered in Norfolk, Va. and supports military operations around the world.



DoD photo by Lance Cpl. Justin M. Mason, U.S. Marine Corps.

GETTING TECHNOLOGY to the Warfighter

By Ed Mornston, Deputy Military Executive

Last winter, I had the privilege to serve with our geospatial-intelligence analysts in Afghanistan while they worked side by side with our military partners fighting in the Global War on Terrorism. This deployment provided me with firsthand insights into our customers' operations that make me very passionate about our Agency's support to this war and even more impressed with the capabilities of our analysts and the value they bring to the battlefield.

The Global War on Terrorism is well-named because this truly is an epic battle against terrorist networks that are not limited to a particular region. This war is deadly, it is asymmetric and it is rapidly changing. These types of combat operations stretch our military forces both in terms of physical demands on soldiers and their equipment, but also in terms of the vision and capabilities needed to fight against adversaries who operate at the confluence of terrorism, insurgency and perhaps weapons of mass destruction.

Geospatial intelligence (GEOINT) provided by NGA and our partners in the National System for Geospatial-Intelligence is absolutely critical on the battlefield. But, to be truly supportive of the warfighter and remain so, NGA needs to

understand how GEOINT, a major combat multiplier, must adapt to the environment in which U.S. and coalition forces are operating, and how we should interact with them to deliver these enhanced capabilities.


For the purposes of this article, I will focus on three thoughts about our military partners and their operations and how these insights should guide NGA on interacting with military commanders and operators in forward-deployed locations.

Context Keeps Changing

The first thought is that to bring new capabilities to our military partners, we must truly and completely understand the context in which they exist and the environment in which they operate. Our military is fully engaged and very much focused on the deadly fight that consumes their attention. The major combat elements of each of the services have been deployed into combat at an unrelenting pace for the past three years, and there is no end in sight. Our forces are either on their way to fight, in the fight, or returning from long and difficult deployments. And, this fight is new and different. It pits us against a very smart, disciplined enemy that is causing our military to rapidly adapt and then readapt.

We must keep at the front of our minds that the military is paying a dear price in this war in terms of loss of life and limb and that these sacrifices are always very much on the minds of our warfighters.

Knowing that our military partners are very desirous of any capability that will help in this



Lt. Manuel Zepeda (left) and Cpl. Austin Hall (right) compare physical features of the terrain with those on a topographical map of the region near the Afghanistan/Pakistan border. A map is one of the many GEOINT tools that NGA can deliver to the warfighter.



DoD photo by Spc. Harold Fields, U.S. Army

Soldiers establish a security perimeter after exiting a U.S. Army CH-47 Chinook helicopter during a Quick Reaction Force exercise at the East River Range near Bagram, Afghanistan. To win the War On Terror, both the warfighter and NGA must be aggressive in their pursuit of mission excellence.

fight in the future, but very much focused on current operations is an important piece element of situational awareness that we must keep in mind about our partners.

Need to Share Capabilities

The second thought is that we must determine, working closely with our military customers, what capability they truly need and will make them more effective. The challenge with this is that neither party has a firm grasp of how to work in each other's sphere of influence.

At NGA, we need to fully understand the operational environment and doctrinal principles by which our forces fight. As mentioned above, this war is very different from others in which we have fought, and is further complicated by the speed at which new techniques and innovative methods are introduced to the battlefield by both friendly and threat forces. Understanding the dynamics of this war is not easy, and

is even harder as a national Agency that is largely based in the continental United States.

Working to develop an understanding of our partners is necessary because, in general, they need help in being able to communicate effectively with us about their needs. In essence, warriors don't know what they don't know about GEOINT, and we are in the same situation about setting up a snap traffic control point in Ar Ramdi, Iraq or raiding a suspected terrorist compound in Khowst, Afghanistan. Only by working together can we get into each other's space to understand how to bring greater capability to the fight.

Stand-Alone Solutions Inadequate

My third thought is that pure and stand-alone technology solutions are difficult to integrate into a situation in which military forces are concentrating on other fights. We should strive to deliver a well-packaged

capability that can be added to ongoing operations without major disruption. For instance, a hardware or software upgrade, new tool or new concept should be matched with the concept of operations by which it will work, a detailed training package, a maintenance plan, and all of the other elements that make using the new capability “user friendly.”

These three points lead us to conclude that NGA must become extremely well-organized and coherent, and compel us to present our ideas in a tight, focused manner that will make warfighters more effective and capable. Approaching a military customer with a less than fully coordinated, thought-out idea at this point is not helpful and may not be well received.

Working Through NSTs is Key

Our view into the warfighters’ true needs should be through our forward-deployed personnel, NGA Support Teams (NSTs), and the regional and functional offices in the Production and Analysis Directorate who are linked directly to military forces. We need to leverage the knowledge that we gain as an Agency from having people forward and a Production and Analysis element that works with the customer on a daily basis. They are shoulder to shoulder with those whom we are trying to understand and support. The knowledge that is gained from living and working in the same time zone and operating conditions as our partners, and walking in their combat boots, is a very unique, invigorating experience, and one that gives us insights into their needs.

The key to bringing a coherent and well-targeted plan for enhanced GEOINT capabilities to those who are very busy is to work through our NGA Support Teams that have a full-time, enduring, deep relationship with the combatant commands and units in the field. Our NSTs, as our Agency’s element that is charged with

managing all aspects of our interactions with the commands, must not only be consulted with on technology issues, they must concur that bringing a capability and proposing it to a customer is the right thing to do and fits into the command’s battle rhythm. The NSTs must be the clearinghouse for all technology ideas and enhancements that we propose.

Stryker Brigade Debriefing

A great example of interacting with a warfighter who brings the situational awareness that is crucial to NGA occurred recently when NGA had an opportunity to debrief Army Chief Warrant Officer Jason Feser, topographic chief in the 1st Brigade, 25th Infantry Division. Currently operating in Iraq, this unit was one of the first two brigades to make the transition into the lighter, more mobile Stryker Combat Vehicles. Our discussion with Chief Feser resulted from a long-standing relationship that was established through the Army NST at Fort Lewis, Wash. and the Future Warfare Systems Office of NGA’s InnoVision Directorate. It included approximately 100 NGA personnel from the InnoVision Directorate, U.S. Central Command reach-back team, Office of Central and Southwest Asia, NGA College, Military Executive and others.

Chief Feser brought to us a feel for the battlefield, the role of GEOINT, and the challenges in serving the operators and trigger-pullers, who, he reminded us, are the real customers. Many of Chief Feser’s discussion points centered on challenges related to dissemination, data standards and data content.

Imperatives for GEOINT

When we think about what warfighters need in terms of enhanced capabilities, the issue of bridging the “last tactical mile” is near the top of most discussions. Commanders and operators on the ground may not use these words, but when we listen



DoD photo by Spc. Harold Fields, U.S. Army

A U.S. Army soldier brings up the rear while on a dismounted patrol high in the mountains of Nowabab, Afghanistan. Understanding the environment in which the military operates helps NGA analysts provide better intelligence to those who serve in harm's way.

closely to what they are describing, many times the challenges involve dissemination. Getting high-end, dense GEOINT into the hands of "disadvantaged users" who are well forward on the battlefield is the issue that many commanders feel is the next big step in GEOINT support to operations.

At higher levels of command, an improved capability for persistent surveillance, new sensor types and new exploitation techniques are often mentioned as desired capabilities. New sensor types (phenomenologies) will greatly expand the spectrum of radiant sources. Combining these new sources with new exploitation techniques will allow us to steal secrets in current and future combat environments. However, as we think about making our military forces more capable, we must keep in mind that technology is not a panacea and must always be developed in concert with our people and processes.

Tapping into the Workforce

Much of the information that is critical to victory on the battlefield has been

developed and is known by NGA experts. We need to match our business model to the collaborative tools and processes that exist and are being used by military commands. This will allow us to bring the entire NGA enterprise into the fight. Many commanders in our military are struck with the growing realization that our network must be better than the terrorist's network and we must share all information accurately and quickly if we are to prevail in this fight.

In my estimation, the greatest capability we can provide to those who are fighting is the full range of NGA's existing GEOINT expertise that resides in our analysts and workforce who are not forward-deployed. Because many commands are becoming more reliant on GEOINT and are increasingly innovative in how they employ our tradecraft in combination with the power of other intelligence disciplines, the proactive engagement and push of ideas, expertise and products from our home-station analysts is crucial. This can happen because the ability now exists to connect analysts at different NGA sites to personnel in the field with the customer.

It is crucial that at NGA we get this right. I believe that the key to developing and integrating GEOINT capabilities lies in our intense study of those whom we want to help, and in a very tightly organized plan to integrate these capabilities into their operations. NGA is performing magnificently on the battlefield with our warfighting partners. Our analysts and other members of our workforce are true heroes and recognized as such in the field. We must learn from their experiences. It is necessary that we continue to aggressively enable our military forces to win this fight because our foes are targeting our families and our freedoms.

National System for GEOINT Aims to Eliminate Barriers

By John Doty, Joe Klimavicz and Jennifer Lafley

Intelligence Community (IC) leaders have made it clear that there must be much more information sharing across organizational and functional lines. At the same time, the efforts of NGA analysts, customers and partners are too often slowed by navigation through various systems, procedures and functions to gather information before actually doing their work.

To maximize the availability of data and capabilities, the transformation of the National System for Geospatial-Intelligence (NSG) is, before anything else, an integration function. It is also preparation for an environment in which much more source data is available to analysts and users.

A key transformational change in NGA business operations is the consolidation of contracts for system processes and functions. With a prime contractor and team of subcontractors, existing systems are integrated with each other and future NSG elements. The consolidated contract vehicle for the acquisition of systems and their integration into a larger national system is called GeoScout. The contract vehicle to consolidate operations and sustainment of systems, technology and services is called Information Technology/Information Services.

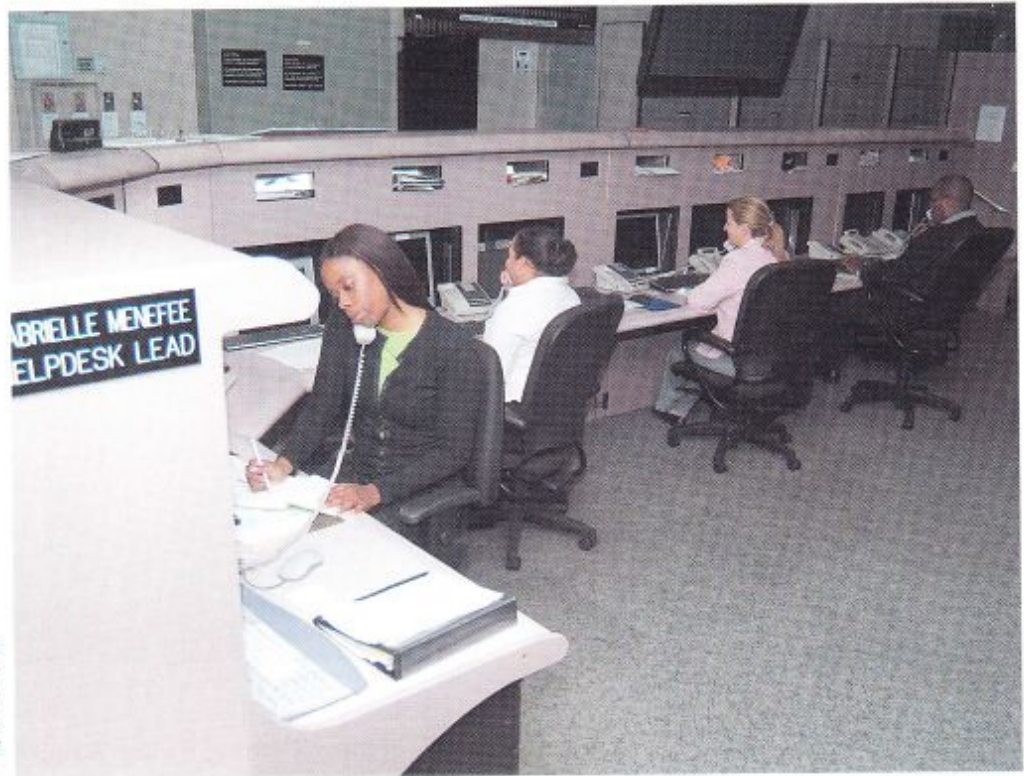
Infrastructure Comes First

NGA's Information Technology Strategic Plan outlines clear, comprehensive, enterprise-wide strategies. As NGA implements the plan, the Agency is shifting from tightly coupled, inflexible hardware, software and data systems to open systems that allow applications to "ride" across a core infrastructure.

NGA's Enterprise Operations Directorate is working in partnership with the Acquisition Directorate, Security and Installation Operations Directorate and core contractors to evolve a holistic enterprise infrastructure that ensures fail-safe business continuity and processing on demand across the NSG. That transformed infrastructure will be fully digital, self-aware, self-reporting, self-healing and self-sustaining. Users will have self-service and instant, real-time access to geospatial intelligence (GEOINT).

Replacing old infrastructure and improving access to information services comes first. Several projects under way to:

- Modernize administrative and secure phone systems, ensuring that every desk has a phone with voice mail and all secure phones are interoperable with IC partners;
- Recapitalize desktop workstations on a four-year cycle (and laptops on an as-needed basis) to guarantee cost-effective, reliable employee productivity;
- Automate problem reporting through automatic call distribution in which callers with specific problems are referred to the appropriate experts through automated telephone or Web options;
- Improve NGANet inter-building reliability and availability through a network stabilization initiative;
- Establish robust, high-speed campus networks to support increased collection capacities and reliability requirements;



The NGA Help Desk assists employees with technology issues. Callers will soon be referred to the appropriate experts through automated telephone or web options.

- Consolidate data storage into two data centers and migrate holdings from various sites to those centers, reducing cost, providing redundancy and ensuring continuity of operations;
- Develop and implement automated problem detection and resolution for the NSG infrastructure;
- Enhance the performance of legacy production systems.

A related component of the NSG objective architecture is access. The NGA Portal—the first step toward collaboration across the NSG—provides access to GEOINT through Web-based multiple-security-level servers. Integrating existing and new content, the NGA Portal will become the single entry point for customer and user access to NGA information and services.

Managing the Transformation

The Acquisition Directorate is home to contracting officers who administer contracts throughout NGA, engineers

who develop requirements and control processes, and program managers who deliver system elements through acquisition projects. As manager of the GeoScout contract, the Acquisition Directorate is directly accountable for delivery of the transformed NSG with critical attention to cost, schedule, performance and risk.

Because the transformation is a monumental task, GeoScout delivers integrated capability in sets or blocks (and increments of blocks). In Block 1, the focus is on upgrading NGA and NSG infrastructure as necessary to support subsequent integration efforts. Block 1 deliveries are well under way, with increments on schedule for installation and integration. Achievement of these Block 1 successes has been possible only through close coordination between Enterprise Operations and Acquisition in a joint unit that oversees infrastructure development.

In Block 2, the focus is on managing information and its sources (the holdings

and source elements of the objective architecture). The delivery of prototype capabilities in the next year will allow the NSG community to participate in their development. These near-term prototypes involve several key areas:

- Visualization—the capability to overlay various information sets onto a geospatially referenced base and apply various tools to the analysis process,
- Needs management—the generation and decomposition of intelligence information needs through the integration of tools that identify discrete requirements,
- Workflow management—the use of new and existing capabilities to create transformation workflows, especially in the production and discovery of GEOINT.

In Block 3, the NSG will approach its objective architecture, or end state.

Inserting Emerging Technologies

NGA Director retired Air Force Lt. Gen. James R. Clapper Jr. has created an Industry Interaction Program to ensure appropriate access for companies to introduce their capabilities and new technologies. The program provides a formal, disciplined process for interaction with industry and ensures consistency in approach across the Agency.

As NGA's proponent for research and development, the InnoVision Directorate surveys emerging technologies, methods and capabilities in GEOINT and allied fields and identifies key candidates for inclusion in the NSG. Directorate personnel work closely with the GeoScout program on various initiatives to insert emerging capabilities into the transformed NSG.

InnoVision personnel have designed a flexible technology-insertion process to accommodate the great variety of technologies that flow into the baseline. The path and speed by which a capability is inserted depend on such factors as type of technology, target-user environment, and urgency of need. Decisions on technology-insertion investments are made by a Rapid Innovation Council. For more information about the Council, read the separate article in this issue.

A key effort is the Geospatial-Intelligence Knowledge (GKB), featured in the January-February 2005 Pathfinder. The GKB is part of a larger concept—Knowledge Management (see sidebar on page 30).

NSG End State

Collaboration, a key component of analysis, will increase opportunities for subject matter experts to engage across national, agency and discipline lines. Elements of collaboration introduced in GeoScout Blocks 1 and 2 will mature as they move toward the NSG final form.

In GeoScout Block 3, the NSG will approach its steady state—transformed to respond at a faster operational tempo to the larger volumes of data available and the evolved needs of the GEOINT community. The GKB—engine of the integrated information environment—will be fully operational. Persistent surveillance—continual monitoring and collection—will enable the NSG to operate at an entire new level of effectiveness. And emerging technologies will have an avenue for insertion into the national system.

Knowledge Management and the GKB

By Danielle Forsyth

Knowledge management (KM) is a broadly used term without universal agreement on its definition. The term is used to describe everything from traditional document management and lessons-learned databases to automated capture and reuse of tacit knowledge.

The key purpose of KM is to help an organization effectively leverage ever-growing assets, including intellectual capital. KM does this by capturing and sharing information, experience, expertise and insights, promoting collaboration, and providing broad access to the organization's information assets without regard to their source or structure. A true KM system tracks the context and relationships among the data and information so they can be rapidly understood and acted upon.

NGA's Geospatial Intelligence Knowledge Base prototype (GKB-p) is embracing emerging KM technologies to allow users to describe their communities of interest, to subscribe to automated alerts and notifications, to save data and knowledge in an "electronic shoebox" and to notify communities when projects or findings are published. It will also help analysts to identify non-obvious connections, capture and share knowledge, facilitate analysis through advanced visualization, and track processes so that "recipes" can be re-used to pose and test hypotheses.

KM should not be a separate process on an isolated system. Instead, it should provide users with ubiquitous access to data and knowledge through known and trusted applications, allowing access to critical data and knowledge that exists both within and outside the Intelligence Community for analysis and decision-making.

Knowledge tools will work seamlessly with today's data and systems. At the same time, seamless transition between traditional applications and new advanced visualization capabilities are at the core of the NGA KM philosophy. Analysts will be able to navigate through changing knowledge structures and view data and knowledge in familiar or new applications or services.

Visualization tools will provide multi-dimensional views for analysis and understanding and support the rapid identification and annotation of patterns, connections and relationships.

Analysts need access to data, knowledge, experience and expertise. KM at NGA is focused on breaking down barriers so that analysts can capture knowledge, index and search through a wide range of client types.

Analysts are set to begin testing the GKB-p in October. This testing will be done by a business-process re-engineering team that has worked closely with developers from the early days of the project.

Council Ensures Rapid Technology Insertion

By Colby Harmon

Taking advantage of the accelerating pace of advancing technology requires an equally rapid means of assessing and deploying innovations as they emerge. NGA has established a Rapid Innovation Council (RIC) to meet this challenge.

Endorsing the plan for standing up the RIC, NGA Director retired Air Force Lt. Gen. James R. Clapper Jr. said, "I am very committed to strengthening the manner in which we manage innovation."

The RIC is a formal cross-directorate executive forum chaired by the Technical Executive and comprised of the line-organization directors, the Military Executive,

the Financial Management Directorate and the Office of Geospatial Management. The Council is the governance mechanism for

prioritizing and providing resources for emerging technologies and other innovations that could not have been accounted for within the Agency's two-year program planning cycle.

The innovation expenditures being made by the RIC are generally required within 6-18 months. In the past, funding for inserting break-through innovations had to be reallocated from other planned efforts. The RIC now manages the distribution

of NGA funds that have specifically been set aside to enable technology-insertion activities related to the initial implementation and sustainment of new, high-value innovations.

The RIC Support Team recommends specific technology insertions after assessing the maturity, suitability and other factors related to individual technology-insertion candidates. Co-chaired by the Deputy Technical Executive and the NGA Chief Architect, the Support Team has broad representation from Agency organizations involved in planning, developing, acquiring, implementing and sustaining new technologies. A Technology Assessment Group comprised of enterprise engineering contractors conducts rigorous assessments of each proposed innovation for the Support Team.

By improving NGA's effectiveness in carrying out the technology insertion, the RIC is shortening the time from an innovation's discovery to its first use in operations. Equally important is the act of identifying shortfalls in NGA capabilities that will most affect the Agency's ability to serve its customers now and in the future. One of the tools being developed to support gap analysis is the NSG Capability Roadmap, which links identified capability needs to resource allocations. Another important ongoing development is the Enterprise Technology Roadmap, which will link candidate technology insertions to capability needs.

"I am very committed to strengthening the manner in which we manage innovation."

NGA Improves JPEG2000 Performance for GEOINT

By Alec Klatchko

The volume and diversity of geospatial intelligence (GEOINT) data is rapidly multiplying. Vastly greater numbers of pixels are being produced from an increasing variety of sources ranging from National Technical Means to commercial satellite imagery to handheld collectors and more. Further complicating the situation are the many different formats of image data being produced—gray scale, color, multiband and more.

On the other end of the imagery thread, the number of end-users is increasing due to the availability of affordable, high-quality imagery exploitation systems based on open-standard commercial off-the-shelf products. NGA's diverse customers range from imagery scientists conducting highly detailed scientific analyses to customers who can accommodate only small subsets of original data due to system and connection limitations.

In an effort to address the volume and diversity of imagery, Congress in 2001 directed NGA to take the lead in developing imagery infrastructures to exploit the opportunities provided by an emerging data compression standard: the Joint Photographic Experts Group (JPEG) 2000 compression format. In the commercial world, JPEG2000 product lines promise to hold a very large presence. Existing imagery compression formats had previously addressed the issues of size, diversity and volume. However, these formats can only be applied ad hoc and do not allow NGA to achieve infrastructure integration.

With JPEG2000, NGA has expanded the methods of managing, distributing and exploiting GEOINT data to achieve

infrastructure integration in a cost-effective manner that preserves critical metrics for quality, timeliness and performance.

IEC Program Takes Lead

NGA's Integrated Exploitation Capability (IEC) Program and its contractor, Lockheed Martin Corp., have taken a leadership role in introducing JPEG2000 to IEC customers and vendors. The IEC is a large digital information exploitation system that relies on current and emerging commercial technology. It replaced aged government-built digital and film-based imagery processing and analysis systems that used specialized software coupled with engineered hardware.

IEC Program engineers assisted vendors in developing a JPEG2000 capability into their product lines. At the same time, they adapted JPEG2000 to IEC performance standards to ensure smooth functioning of the exploitation chain with the new image-compression format. MITRE, a not-for-profit company chartered to work solely in the public interest, provided expertise in JPEG2000, and the government National Imagery Transmission Format Standards Technical Board provided expertise in standards management.

Following an exhaustive assessment of applicable commercial off-the-shelf products, program managers selected Unisearch's Kakadu tools as the best fit for the needed tasks. Kakadu is a product of Dr. David Taubman of the University of New South Wales in Australia.

The structure of JPEG2000 accommodates many choices on decode (converting the image from a compressed state to

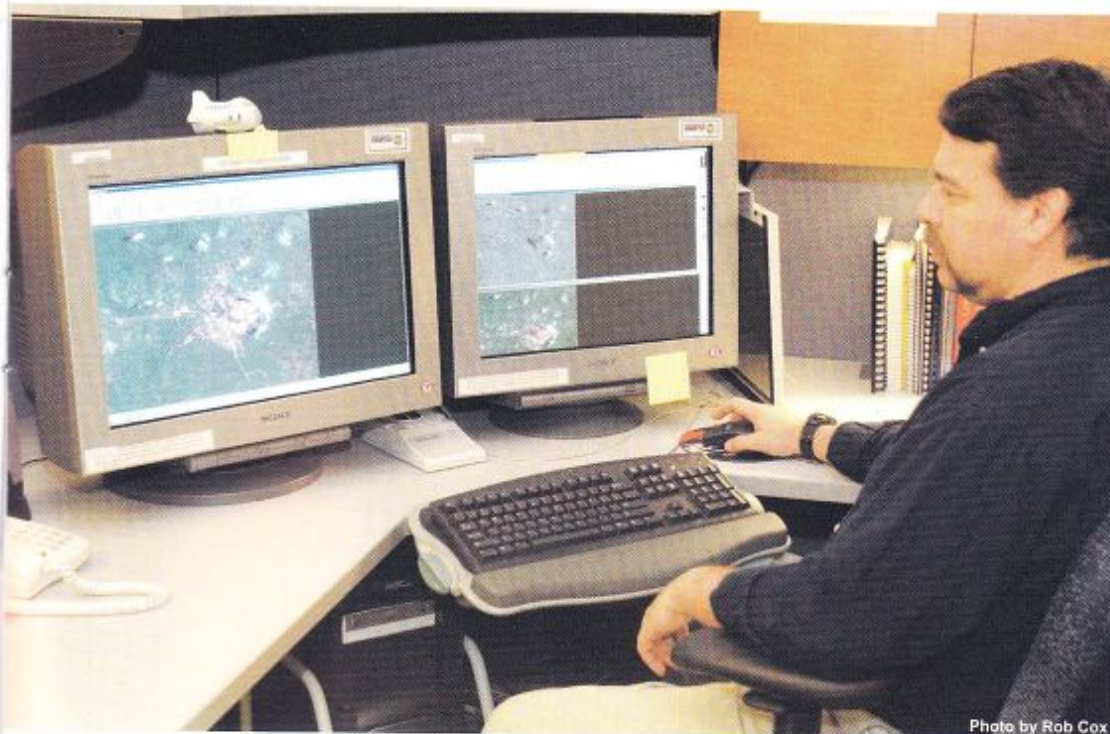


Photo by Rob Cox

The Integrated Exploitation Capability (IEC) is a large digital information exploitation system that relies on current and emerging commercial technology. IEC Program engineers assisted vendors in developing a JPEG2000 capability into their product lines.

a viewable state) which IEC explored analytically and through benchmarking. The results enabled IEC engineers to direct performance improvements in the decode sequence to vastly improve the visual rendering of imagery with a smooth and continuous roam.

Software Providers Benefit

Early analysis and benchmarks revealed that the originally intended form of JPEG2000 imagery was not suitable to a timely and robust exploitation of large JPEG2000 images. The IEC and MITRE engineers jointly discovered that by rearranging the compressed form of the JPEG2000 code stream to a more efficient progression-ordering sequence, the required performance was achievable. This solution identified required changes to Kakadu. The changes were relayed to Taubman, who refined Kakadu with dramatic results. IEC engineers then shared their results with the commercial software providers, who were able to demonstrate

greatly improved JPEG2000 performance.

Sensor Systems, the manufacturer of the Electronic Light Table, RemoteView Pro, accelerated the implementation of Kakadu. A company team was able to demonstrate operational workflows against very large JPEG2000 images essentially identical to non-JPEG2000 encoded data. Demonstrations of the light-table prototype at last year's IEC Users Conference resulted in very positive user comments, many noting the capability for fast and smooth roams.

Some JPEG2000 issues remain ahead of NGA. The great strength of the IEC Program is the ability to apply widely available products and technologies to the specialized needs of our end-users while facilitating the strategic goals and transformation of NGA.

The IEC leverages progress made in the Windows™ realm to deliver cost effective-solutions for JPEG2000 performance, especially with the state-of-the-art dual Xeon CPU workstations, high-speed buffers, and high-end graphics cards. Unfortunately, a similar JPEG2000 technological performance solution on the UNIX baseline is not currently available. The IEC Program is recapping all IEC-provided UNIX workstations to Windows workstations, with a completion date of Sept. 30, 2006 projected.

GEOINT exploitation is now well-postured for the forthcoming JPEG2000 change in the community's imagery architecture.

Our Heritage

New Look at Vietnam War Support

By Dr. Martin K. Gordon

The Corporate History Branch recently completed the first exhibit on the Vietnam War for the NGA Museum in St. Louis. Before preparation of this exhibit, there were no accounts that outlined the contributions of all of NGA's predecessor organizations to American participation in that war. NGA now has a record of the work done back then, thanks to the participation of several retirees: Al Anderson, Charles Bates, Wells Huff, Richard Randall and Vance Sprague.

Just as today's intelligence operations require close collaboration by NGA with other intelligence agencies, the contributions of several organizations were involved in preparing for and supporting our nation's participation in the Vietnam War. Long before the United States formally became militarily engaged in Southeast Asia, the

Army Map Service (AMS), Aeronautical Chart and Information Center (ACIC) and National Photographic Interpretation Center (NPIC) collected data and prepared analyses for that region.

During the tense summer of 1954, there was a strong possibility of U.S. intervention to help the French in their fight for control against the Communist Viet Minh after the fall of Dien Bien Phu. AMS provided analyses of the terrain around the cities of Hanoi and Saigon in case the United States intervened.

The United States did not intervene, but interest in that region continued to grow.

Division of the country followed the French defeat in 1954. In the late 1950s and into the 1960s, contractors assisted the AMS in Bethesda, Md., with aerial photography, and the agency sent survey parties into the region. As a result, AMS created the first accurate maps of Vietnam.

In 1959 President Dwight Eisenhower asked for U-2 missions in Vietnam and the surrounding region and tasked NPIC in Washington, D.C., to study the resultant photographs. NPIC analysts began visits to the region to study and report on the growing conflict between North and South Vietnam. By 1962 NPIC analysts were conducting bomb-damage assessments, identifying possible targets, seeing through enemy deceptions and producing a number of intelligence assessments.

As demands for targeting information grew, along with American involvement on the side of South Vietnam, ACIC in St. Louis deployed a new database targeting system. It enabled attacking American

Air Force reconnaissance photography of the Hanoi railroad and highway bridge, taken in May 1968, shows repair work under way on spans destroyed before a month-old bombing halt. In the upper right are two temporary pontoon bridges for foot and motor traffic. Organizations that preceded NGA supported the American war effort with many new methods and products.





A truck convoy heads south toward the South Vietnam border in January 1968, days before the Tet offensive.

and allied pilots to more accurately hit targets and avoid Communist air defenses. Exploiting SR-71 photography sent to St. Louis, analysts would identify the exact coordinates of newly found targets and send that information back to Vietnam for action. The process took an hour.

Increasing American military involvement required accurate information about the names of natural and cultural features in that country and adjoining countries for application to maps and charts and for overall operational purposes. The U.S. Board on Geographic Names (BGN), headquartered in the Interior Department, provided guidelines for standardizing such names. The AMS survey parties collected names data in the field for topographic maps of Vietnam and other countries, and similar staffs at the Naval Oceanographic Office and ACIC provided names for nautical and aeronautical charts, respectively. Country gazetteers with

standardized names were published to meet various requirements.

Meanwhile, the Army Map Service adapted the land-based, low-frequency Long Range Navigation (LORAN) system to record the location of aurally seeded sensors being dropped to help allied forces interdict North Vietnamese supply and troop movements into South Vietnam. At the same time, AMS provided its traditional mapping support to the Army.

As for Navy involvement, it was evident by November 1965, shortly after our first ground combat troops landed, that coastal charts for South Vietnam, based on Japanese hydrography from World War II, were unreliable, particularly in the river deltas. Consequently, over the next three years the Naval Oceanographic Office completed comprehensive geodetic, coastal and harbor surveys of that complex coastline using a series of survey vessels. Among these were the USS Maury, USS Tanner, USS Serrano, USS Sheldrake and USS Towhee. In addition, during December 1966, the Naval Oceanographic Office established a branch office in Saigon to provide updated nautical charts and publications for use by local fleet and Marine Corps units in their blockade, interdiction and naval air support actions.

As the war moved toward a conclusion, the Department of Defense probed for ways of saving money. At the same time, the military services' use of digital and satellite technology for mapping, charting and geodesy continued to grow. Both to save money and to better exploit these new tools, the Department of Defense merged the services' mapping organizations, establishing the Defense Mapping Agency in 1972.

NGA's Vietnam War exhibit will be open to the public. Watch the NGA home page at www.nga.mil for information as it becomes available.

21st Century

AGI Holds Promise for Essential Change

By Mike Geggus

Our adversaries have learned much about what we can see and hear, and they have taken steps to overcome many traditional intelligence-gathering capabilities. Quick, quiet and hidden, our adversaries have capabilities that enable them to warn each other about reconnaissance efforts we undertake and thwart our follow-up actions through denial and deception.

The Weapons of Mass Destruction Commission appointed by President George W. Bush warned that the Intelligence Community's "effectiveness will continue to decline in the coming years unless concerted change occurs."

NGA recognized this trend long before the commission report and refocused on geospatial intelligence (GEOINT). NGA is changing.

A key part of this transformation is the incorporation of advanced geospatial intelligence (AGI) into the foundation of our business. Formerly known as imagery-derived measurement and signatures intelligence (imagery-derived MASINT), AGI is the technical, geospatial and intelligence information derived through interpretation or analysis using advanced processing of all data collected by imagery or imagery-related collection systems. NGA gained responsibility for AGI from the Defense Intelligence Agency in 2002.

AGI is prompting the Intelligence Community to reevaluate existing approaches to the collection, analysis and dissemination of GEOINT. This new discipline exploits formalized processes to describe phenomena and make predictions. It provides a

structured method for the refutation or confirmation of hypotheses that explain observed phenomena.

Already, NGA has expanded its use of the electromagnetic spectrum by increasing the information content from existing sources, such as synthetic aperture radar (SAR) and electro-optical (EO) systems. SAR provides detailed results like those obtained with a large antenna by tracking the movement between airborne radar pulses.

This expansion promises to continue with the planned addition of government and commercial sensors that are enabling greater exploitation of signal characteristics, improved spectral characterization and, with Light Detection And Ranging (LIDAR), capabilities in the optical region that mirror those of SAR systems.

With the long-dwell and loitering capabilities of Overhead Non-imaging Infrared (ONIR) and airborne AGI platforms, NGA is leading the charge with persistent surveillance. ONIR has provided continuous worldwide satellite-based surveillance and warning of ballistic-missile launches for over 30 years. The Director of National Intelligence recently assigned ONIR to NGA.

Now is the time for NGA to unleash the full potential of AGI, along with ONIR, throughout the Intelligence Community.

AGI Is Crucial Element

An AGI-enabled GEOINT adds depth to precisely understand our environment and to remotely monitor dynamic world events. An energized workforce of GEOINT-savvy

analysts is bringing the National System for Geospatial-Intelligence (NSG) to the realization of full-spectrum operations.

The Office of Advanced Geospatial Intelligence welcomes the direct, active support of NGA analysts and our production partners throughout the NSG in further developing the AGI tradecraft. While members of the Office of AGI have AGI-specific training, analysts with specialized expertise—whether it is weapons of mass destruction, counterterrorism or specific regional issues—have the expertise to integrate AGI into routine analysis and production.

The integration of AGI is changing how we think and approach problems. Success requires analysts to understand what physical phenomenology is associated with the essential elements of information necessary for accurate assessments. For example, if an analyst is monitoring a target, what materials does the analyst expect to be present? Can these materials provide a signature that can be detected with collection assets that the analyst can task? How will the presence of a particular signature impact the confidence of the analyst's intelligence estimate? Conversely, how

will the absence of signature data impact the analyst's assessment?

Analysts need to ask themselves if they have considered all regions of the electromagnetic spectrum. They must consider how to layer AGI with other forms of GEOINT in their analysis and reporting. And they are shifting their thinking from concentrating on high-resolution literal products to the intrinsic value of non-traditional source data.

The shift from a "product" rich enterprise to a "data" rich environment provides avenues for discovery. By combining established technical data, processes and product standards with AGI data, processes and standards, technologists can uncover new ways to manipulate data and pave the way for additional capabilities.

The importance of AGI is not founded on simply what it is, but what it promises to be. Our challenge is to unlock our thinking, to understand what we can do to advance GEOINT in this domain. All who practice the GEOINT tradecraft have an opportunity to influence the vision and the outcome.

ONIR Is Now Part of GEOINT

By John Morris, Director, GEOINT-ONIR Transition Office

Overhead Non-imaging Infrared (ONIR) has been around for 35 years operationally. It provides 24x7 surveillance of the entire Earth to detect and warn the nation of ballistic missile launches. The intelligence applications were previously assigned to the Central MASINT Organization and later assumed by the Defense Intelligence Agency.

The system was originally designed to detect "big bright events" and report very quickly—in seconds. Over time, the capability has improved in spatial capability, as well as in data fidelity overall.

Due to these improvements and the need to expand the customer products to the full potential of the new collection systems, the Director of National Intelligence reassigned the Intelligence Community management responsibility from DIA to NGA in July 2005. NGA is standing up a GEOINT-ONIR Transition Office (GTO) to manage these new responsibilities.

Industry

Small Companies Help NGA Make a Difference

By John Findley

Small technology companies have much to offer," says Nancy Groves, NGA Small Business Innovation Research (SBIR) Program Manager. NGA participates in the program to make sure their contributions are not overlooked. Intelligence agencies are not required to participate, and NGA is the only intelligence agency in the program.

"Studies and anecdotal evidence tell us that small firms have a number of advantages over large firms when it comes to innovation: greater flexibility, closer contact with customers and greater willingness to engage in high-risk research and development projects," says Daniel O. Hill, Assistant Administrator for Technology, U.S. Small Business Administration. "These qualities have made small firms the leaders in industrial innovation, producing more innovations per employee and per dollar spent on research and development than larger firms."

However, the risk and expense of conducting research and development is beyond the means of many small businesses. By funding the critical startup and development stages, SBIR enables small businesses to compete on the same level as larger businesses. At the same time, the SBIR program stimulates the U.S. economy by encouraging the commercialization of technology, products and services of small businesses.

How SBIR works at NGA

NGA recognizes the value offered from small innovative entrepreneurial companies and sets aside funds annually for:

- Two initial proposals that test the scientific, technical and commercial merit and feasibility of a particular concept, and
- Two advanced proposals that build upon the success and merits of initial awards to develop commercially marketable prototypes.

The InnoVision Directorate, through its Basic and Applied Research Office, manages SBIR for NGA. The Office solicits research topics representing Agency interests, provides guidance for participants, and monitors accepted proposals. The program is completely unclassified, allowing a wide range of vendors to compete for contracts. Outreach activities are designed to introduce the program to small businesses owned by women and minorities.

Following completion of an advanced proposal, small companies are expected to obtain funding from the private sector and/or non-SBIR government sources to develop the concept into a product for sale in the private sector and/or military markets.

SBIR successes

For the government as a whole, success in the SBIR program is measured by how many awards evolve into commercial products.

For NGA, success is also measured by the impact and effect of SBIR awards on the transformation of the defense and intelligence communities to meet current and future challenges.

The following SBIR awards illustrate how the program enables transformational research to meet tomorrow's challenges:

"An important strategy for our research program in InnoVision is to reach out and engage the best minds with our most daunting challenges. The SBIR program provides us with an important channel for doing this by providing access to the innovation capacity of small companies."

*—Dr. H. Gregory Smith,
NGA Chief Scientist*

Full-Spectrum Sensors. Essex Corp. is using Synthetic Aperture Radar (SAR) to investigate the creation of three-dimensional imagery that could be used to detect manmade objects like buildings. SAR

provides detailed results, like those obtained with a large antenna by tracking the movement between airborne radar pulses. The investigation involves the use of tomography in a technique similar to medical CAT scans that combine a series of "slices" to produce a three-dimensional pic-

ture of the body. In one of many potential applications, users interactively retrieve information about three-dimensional models stored in a geographic information system.

Vexcel Corp. is also using SAR tomography to penetrate forest canopies and characterize both the foliage and underlying terrain. In this project, multiple data collections of the same scene over a large range of radar wavelengths are being used to create true, three-dimensional, volumetric images.

GEOINT Knowledge Base. Physical Optics Corp. has a project to inexpensively generate Digital Terrain Elevation Data (DTED®) Level 2 above 60 degrees north latitude, filling a critical gap. (Level 2 provides elevation data at a resolution of 30 meters (98 feet). NASA's space shuttle in 2000 gathered data that NGA used to

generate worldwide coverage of DTED® Level 2 between 60 degrees north latitude and 56 degrees south latitude. DTED® is a principal product of NGA.)

Physical Optics has developed a software package that can generate DTED® Level 2 from declassified Russian TK-350 and KVR-1000 satellite imagery. Users will be able to plug the data into commercial software packages. Although focused on using the declassified Russian source material, the project can also use other sources. Commercialization of this product allows NGA an alternative data source to populate its data holdings and provide data users with a potentially inexpensive source for terrain data.

Information Extraction and Transport Inc. is helping users of geographic information systems to measure the reliability of elevation data from multiple sources, among several technological advances developed under an SBIR award from NGA. The technology has immediate application for rapid integration of terrain data to support crisis operations.

Persistent Surveillance. The NAVSYS Corp. has developed a software platform, built on an existing Army-sponsored SBIR, that integrates Global Positioning System inertial and digital camera data. Called GI-Eye, the product can be used in both airborne and ground vehicles to locate and geo-register geographic features and collect attributes about them, among other applications. The company has commercialized the system and delivered it to NGA for rapid surveying, targeting, intelligence, surveillance and reconnaissance applications.

Next-Generation Analytical Tools. Areté Associates is using advanced algorithms with modeling and simulation techniques to passively detect targets concealed by foliage, clouds, or haze. The project

uses an inertially stabilized skyball with multi-channel visible and infrared sensors for remotely piloted long-range surveillance. This capability has geospatial applications in both ocean and terrestrial surveillance.

Applied Signal and Imagery Technology Inc. has developed algorithms that automatically and accurately detect targets in hyperspectral imagery, while providing a cost-effective solution for high-volume processing. The company is developing software prototypes that are compatible with existing NGA tools and enhance detection capabilities for various types of signatures involving chemical and other targets of interest.

Visit Our Web Site

InnoVision encourages employees and organizations to take advantage of this inventive and energizing program. If you

have ideas for a research topic, please contact NGA's SBIR manager, Nancy Groves, at (703) 735-3097 or visit the NGASBIR web site at <http://www.nga.mil/sbir>.

In addition to NGA, 11 federal departments and agencies annually participate in the SBIR program by designating research and development topics, soliciting proposals and granting awards. Additional information regarding these agencies and research topics can be found at the following Web sites:

The Department of Defense:

<http://www.dodsbir.net/>

The Small Business Administration:

<http://www.sbaonline.sba.gov/SBIR/>

Securing the NAVSYS camera in preparation for a target positioning test



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Partnerships

NGA and DARPA Collaborate on 'Hard Problems'

By Matt Reiner

NGA and the Defense Advanced Research Projects Agency (DARPA) held a joint symposium Sept. 7 to solicit input from industry and academia to solve NGA's hard problems and enable the Agency's transformation objectives.

The demand for GEOINT continues to grow in response to the global war on terrorism, changing dynamics on the modern battlefield, natural disasters and support to the Department of Defense, Department of Homeland Security and Intelligence Community. This increased demand requires NGA to task, collect, process, exploit, disseminate and manage much higher volumes of data and information. DARPA can help NGA meet these demands.

The directors of NGA and DARPA signed a Memorandum of Agreement in January for a long-term cooperative program. The agreement calls for the two agencies to "collaborate in the planning, program implementation, program execution, transition and operationalization of innovative technologies, which will enable NGA's transformation to meet current

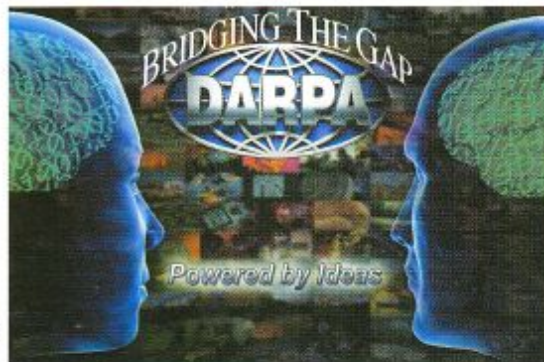
and future geospatial-intelligence mission challenges."

Projects will be jointly funded and managed by both agencies, and NGA will serve as the technology transition partner.

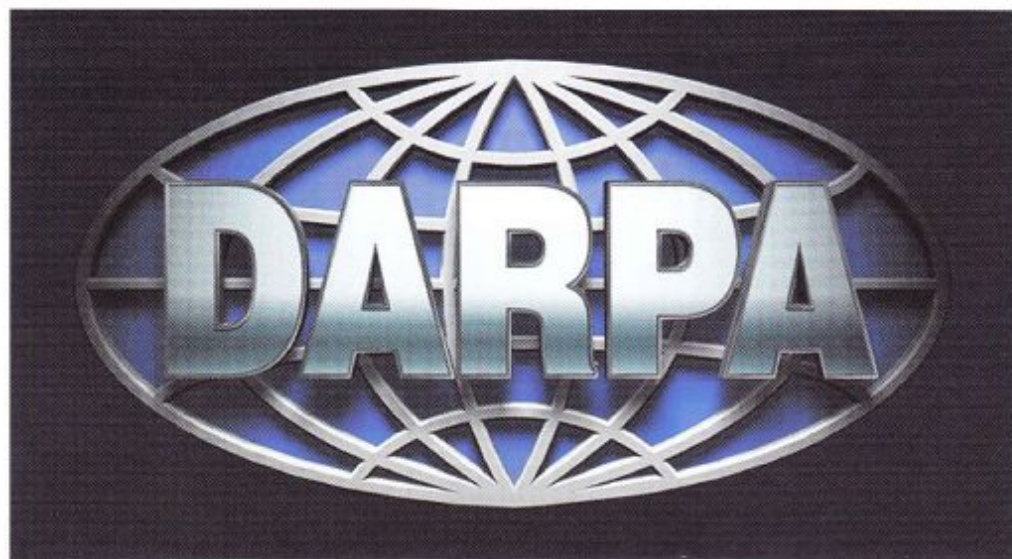
DARPA Director Dr. Tony Tether and NGA Director retired Air Force Lt. Gen. James R. Clapper Jr. co-hosted the joint symposium for industry and academic professionals. The workshop focused on NGA's hard problems, which will be jointly pursued under the partnership.

Directors of NGA line organizations presented NGA's operational challenges and capability gap areas for industry to propose new ideas and concepts that will lead to viable technological solutions. In return, three DARPA program managers briefed samples of current and future projects that address a few of NGA's technology interests.

One the projects, NeuroTechnology for Intelligence Analysts, is an initiative to help the analysts use intrinsic brain signals to improve the throughput and accuracy of imagery analysis. The All-Things Repository is a program to create a capability to store, retrieve and mine enormous quantities of data for rapid access and retrieval. And Persistent Exploitation of Persistent Sensing is an exploratory research project to recognize targets and events by observing and modeling ongoing normal activities in a sensor-rich environment. In addition, DARPA contract management personnel described the DARPA mechanisms by which industry can participate in the joint program.



DARPA's technical expertise will assist NGA in its transformation effort.



Established in 1958, DARPA has a mission "to assure that the United States maintains a lead in applying state-of-the-art technology for military capabilities"

and "to prevent technological surprise from adversaries." DARPA brings considerable funding and world-class technical expertise to its partnership with NGA.

Analysts from NGA "are assessing DARPA advanced exploitation and target-recognition

technology for its application to their operational missions," says Dr. Young

Suk Sull, NGA Liaison to DARPA. Scientists from the two agencies are also collaborating on advanced mathematics, neuroscience and counter- underground facility capabilities.

At the same time, junior- to mid-level personnel from NGA are participating in the DARPA internship program, which involves a three-month, on-site opportunity for an NGA employee to learn DARPA's culture and the unique missions of DARPA's offices, while articulating NGA mission challenges and technology needs to DARPA program managers.

"The DARPA-NGA partnership is a win-win opportunity for both organizations," Sull notes. "NGA leverages DARPA research and development expertise, and resources for solving NGA's hard problems, while DARPA assures its transition partner in NGA for the common purpose of meeting nation's security objectives."

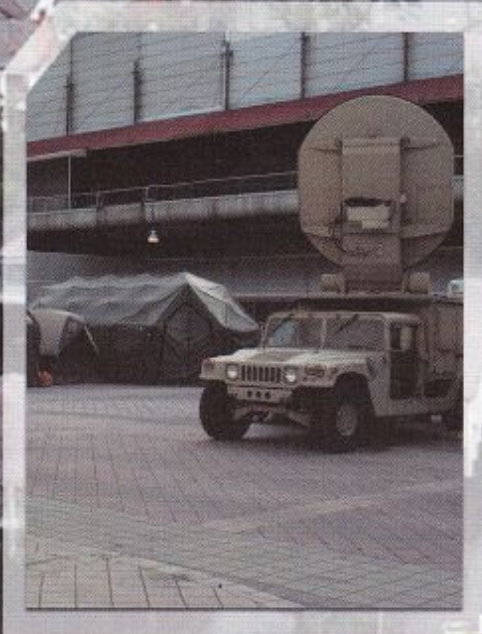
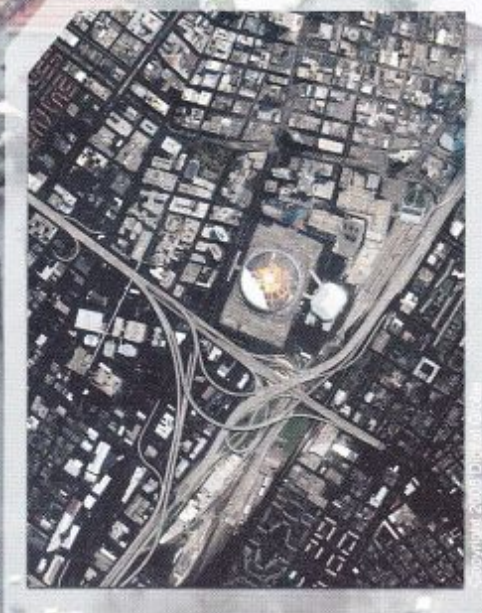
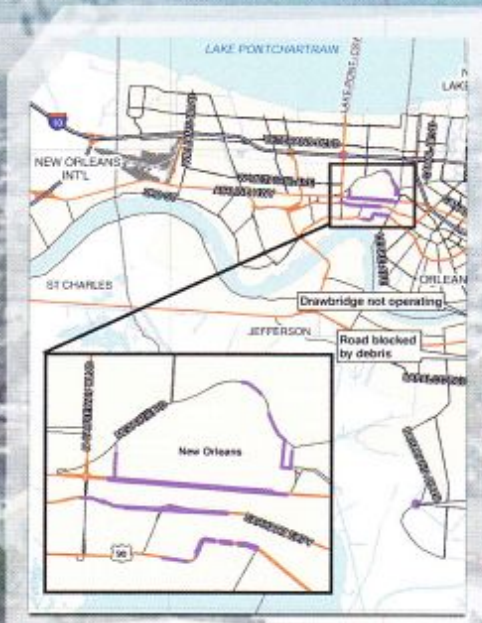
"The DARPA-NGA partnership is a win-win opportunity for both organizations. NGA leverages DARPA research and development expertise, and resources for solving NGA's hard problems, while DARPA assures security objectives."

—Dr. Young Suk Sull,
NGA Liaison to DARPA

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