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Insights

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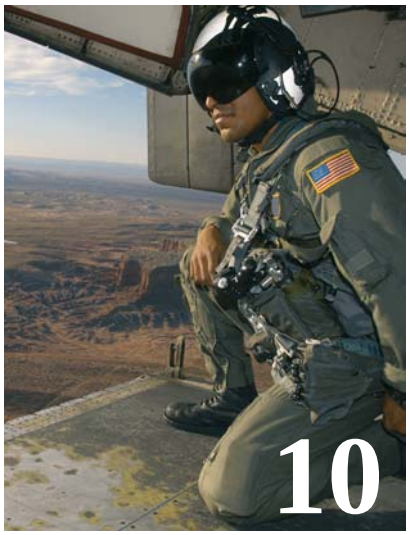
Strategies and Advancements in Net-Centric Operations

Lockheed Martin opens its Swift experimentation lab in the UK to evaluate and develop transformational solutions using network enabled capabilities. Read the story in "Net-Centric Connections" on page 28.

Insights



Inside

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A Conversation

with Lt. Gen. James R. Clapper (U.S. Air Force-Ret.)

Q: During your tenure at the National Geospatial-Intelligence Agency from September 2001 to June 2006, what are you most proud of, both personally and professionally?

Gen. Clapper: On a personal note, I am extremely proud of, and humbled by, the professionals at NGA. I learned a lot about the analysis tradecraft, geospatial intelligence processes and new technologies, but also leadership, communication and customer service. It was a pleasure coming to work every day and a distinct honor to lead a team that is sharply focused on making a difference in the lives of others and contributing to our national security.

Professionally, I am most proud of our team's resilience and perseverance in defining and then growing the concept of geospatial intelligence. I feel like we have effectively created a new intelligence discipline that has the power and value-added effect to truly provide timely, relevant, and accurate support to decision-makers, whether they are in the White House, the halls of Congress, or the foxhole, cockpit or bridge.

Q: What are the origins of 'GEOINT' — how did NGA pioneer the concept?

Gen. Clapper: I began my tenure at NGA two days after 9/11 and not long after the release of the pointedly critical Congressional NIMA Commission Report – the National Imagery and Mapping Agency being the precursor organization to NGA. I would note that the NIMA Act of 1996 had envisioned the melding of imagery, imagery intelligence and imagery analysis with the tradecraft of mapping, charting and geodesy.

However, it was not until the aftermath of the 9/11 terrorist attacks that we really embraced the need to change. In a sense, the NIMA Commission provided the roadmap and the events of 9/11 provided the impetus for action.

In November 2003, NIMA was authorized to officially change its name to the National Geospatial-Intelligence Agency and geospatial intelligence was formally recognized and defined (in federal law). As well, the formal definition established equal status between NGA and other sister agencies.

Continued on Page 4.

BIOGRAPHY

Lt. Gen. James R. Clapper, Jr. (U. S. Air Force-Ret.), served as the first civilian director of the National Geospatial-Intelligence Agency. He retired from that position in June.

He was director of the Defense Intelligence Agency until his retirement as a lieutenant general from the U.S. Air Force after a 32-year career. Earlier assignments included a variety of intelligence-related positions such as assistant chief of staff, Intelligence, Air Force Headquarters, during Operations Desert Shield and Desert Storm, and as director of Intelligence for three war-fighting commands: U.S. Forces, Korea; Pacific Command; and Strategic Air Command.

Lt. Gen. Clapper has served as a consultant and advisor to Congress and the departments of Defense and Energy, and as a member of government panels, boards, commissions and advisory groups.

He has earned a bachelor's degree in government and politics from the University of Maryland, a master's degree in political science from St. Mary's University, San Antonio, Texas, and an honorary doctorate in strategic intelligence from the Joint Military Intelligence College.

He has received the National Security Medal from the president and been awarded two National Intelligence Distinguished Service Medals, the Defense Distinguished Service Medal with Oak Leaf Cluster and the Air Force Distinguished Service Medal.

Lt. Gen. James R. Clapper, (U. S. Air Force-Ret.) Outgoing Director National Geospatial-Intelligence Agency

Continued from Page 3.

By way of background, the statutory definition of geospatial intelligence — GEOINT — is: "the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the earth." Geospatial intelligence consists of imagery, imagery intelligence and geospatial information.

I would also mention that in December 2005, the statutory definition of geospatial intelligence was amplified by the Office of the Director of National Intelligence (ODNI). It now incorporates all Overhead Non-Imaging Infrared and what used to be referred to as Space-borne Imagery Derived MASINT (measurement and signature intelligence).

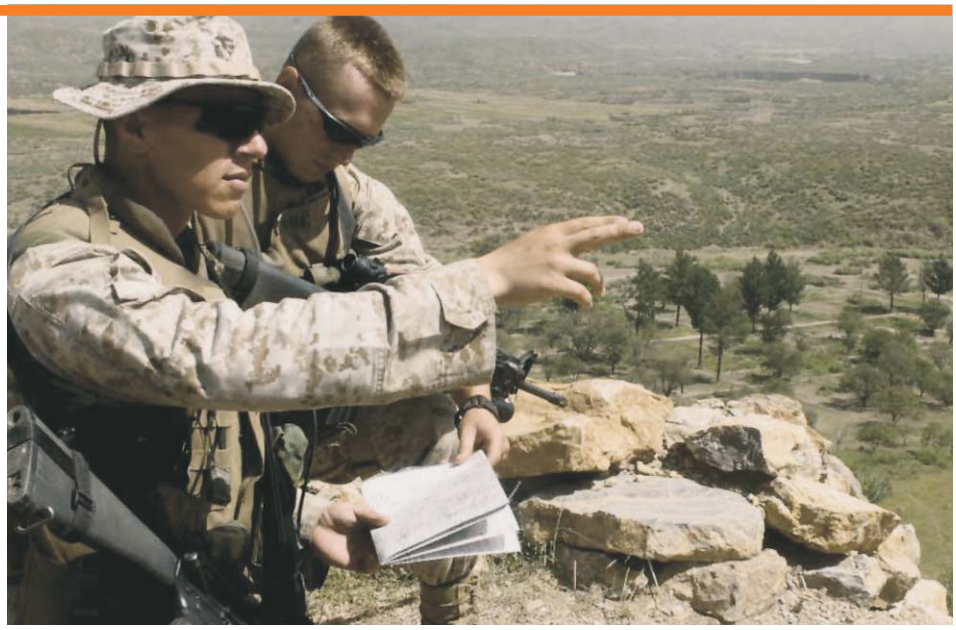
In passing the baton to the next director, I am very proud to note that steady progress is now paying off for NGA. With a statutory definition and amplifications from the ODNI that clearly delineate lanes for NGA and other disciplines, I believe NGA and geospatial intelligence have "arrived."

Impact of the 'Global War on Terrorism'

Q: You touched on the events of 9/11 as a catalyst for change at NGA — how has the Global War on Terrorism affected operations at NGA?

Gen. Clapper: It has served to accelerate the pace of change and transformation at NGA. We have moved from being focused on producing maps and pictures, to a mindset that is geared toward combining multiple data sets to produce and deliver tailored solutions in the form of geospatial intelligence. For example, in the past we trained and were equipped to produce two-dimensional maps with supporting text. We are now in the business of supporting customers with four-dimensional products that enable visualization and create common operating pictures.

The Global War on Terrorism is being fought as a coalition operation. Given this reality, our approach to intelligence gathering, analysis and dissemination has become inclusive as well. Whereas we once segmented collection along U.S. government lines, we now see collection as a collaborative process, including both domestic and foreign assets to form a "best source" strategy. Our collection efforts have also transformed from a reconnaissance sampling methodology to that of a persistent surveillance approach, enabling us to provide customers a more comprehensive geospatial intelligence picture rather than periodic snapshots.



Another philosophic shift precipitated by the war on terrorism was our approach to customer support. Traditionally, we were a "push" organization — tasking, analyzing and building products that we then "pushed" through distribution systems to end users. This "push model" rarely required forward deployment of our forces and assets. Today, I am proud to say, we have changed our philosophy, now focusing efforts on a "pull system" that is driven by the deployment of our leaders and analysts to hotspots around the world — wherever customers are and the demand for tailored geospatial intelligence exists.

Incidentally, we've been able to apply our "pull" model to operations outside the Global War on Terrorism as well. We successfully deployed dozens of personnel in support of hurricanes Katrina and Rita readiness, response and recovery operations. As well, we supported the most recent presidential inauguration and Olympiads in Turin and Athens.

Joint Geospatial Intelligence Activity

Q: Principally, your customer base is the U.S. military. Given that U.S. warfighting operations are now fully integrated joint operations, where does NGA fit into the joint arena?

Gen. Clapper: In his January 2006 State of the Union address, President Bush characterized the war on terrorism as the "long war," noting that America must prepare to fight and win a long war, the right way. I can say unreservedly that NGA is focused laser-like on supporting our terrorism-warfighting customers who are, and will remain decisively engaged in the "long war."

To be successful in this environment, we understand that neither timeliness, nor accuracy are sufficient in and of themselves — you've got to have both.

To this end, we have partnered with U.S. Joint Forces Command to form the Joint Geospatial-Intelligence Activity to enhance geospatial intelligence support to and from national, theater and tactical users — down to and including "the last tactical mile." Or, "the first tactical mile," depending on your point of view.

A key to this is cooperative, mutually supporting relationships that crystallize around the tenet of "moving data to people, not people to data." NGA and

Joint Forces Command have agreed on an aggressive schedule for this joint intelligence action.

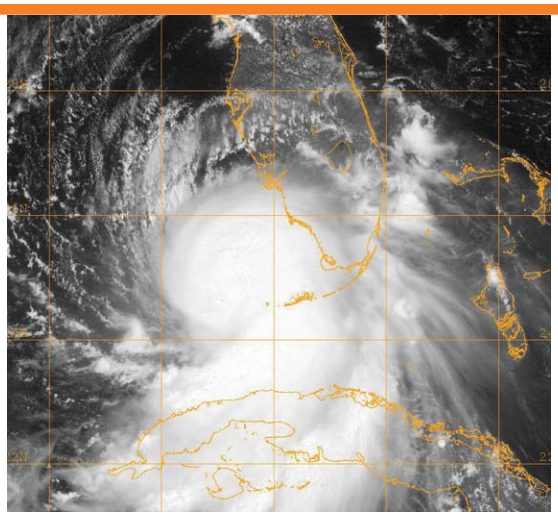
The schedule includes establishing an "as-is baseline" and a "to-be vision." The assessment will also produce a gap and shortfall matrix, an evaluation of potential geospatial intelligence processing and distribution solutions, and an implementation management plan. The joint NGA-JFCOM assessment will be completed in mid-2006, with a follow-on goal for the Joint Geospatial-Intelligence Activity being the ability to influence the fiscal years' 2008-2013 Program Objective Memorandum process.

Supporting Commercial Space Imagery

Q: Shifting focus somewhat, you have mentioned military partnerships; can you describe the NGA experience with industry partnerships?

Gen. Clapper: We have multiple industry partnerships in place, many stemming from the NGA role as the functional manager for the National System for Geospatial-Intelligence, dealing with technology, policy and capability integration across the current multi-intelligence environment.

I would like to highlight specifically our engagement with commercial imagery. To date, NGA has invested approximately $1 billion in the industry for acquiring and developing commercial satellite imagery. We are thus supporting the U.S. Commercial Remote Sensing Space Policy guidance to use commercial remote sensing data, "to the greatest extent possible."



Our ClearView contract vehicle with high-resolution commercial imagery companies has provided nearly $650 million to purchase commercial satellite imagery from the current operational satellites. NGA's NextView contract vehicle has provided more than $350 million to date to purchase imagery from the next generation of commercial imagery satellites. We anticipate the ultimate ClearView and NextView expenditures will be in the $1.5 billion range.

While examples of the utility of commercial imagery in a combat context abound, I want also to cite the value of commercial imagery use by NGA was also both literally and figuratively "brought home" in support of Hurricane Katrina operations.

We assisted in establishing a common operating picture by providing geospatial information about the hurricane-affected areas based on imagery from commercial and U.S. government satellites, as well as from airborne platforms through all phases of the disaster. In all, our analysts created thousands of tailored geospatial products in response to requests from federal, state and local government entities.

Q: From your experience, what are some of the most important future issues or capabilities coming out of the geospatial intelligence world?

Gen. Clapper: Let me start by saying, the power of analysis and the value of geospatial intelligence can be greatly diluted if our products, services and solutions are not readily available and easily accessible. I believe we need to provide Google™ Earth-like applications. By using such "self-service" applications, NGA is shifting from being primarily a producer of geospatial intelligence to also being a service provider as well.

In moving forward, NGA is seeking to "enable" geospatial intelligence by providing access to it through web-enabled services.

The future of enabled geospatial intelligence lies in world wide web connectivity that enables streaming commercial and classified imagery and wireless access to both no-cost and subscription services. Via web-based services, we envision pervasively delivering interactive, tailored geospatial intelligence to a widely variegated customer set, globally.

While the current analytical strength of geospatial intelligence lies in depicting what's where on the earth, we are also pushing this discipline toward a transformation aimed at predictive analysis — enabling users to glimpse into the future. Given ongoing research from both federal and industry teams, and the rapid advancement of technological capabilities, I think the possibilities for predictive geospatial intelligence are both immense and exciting.

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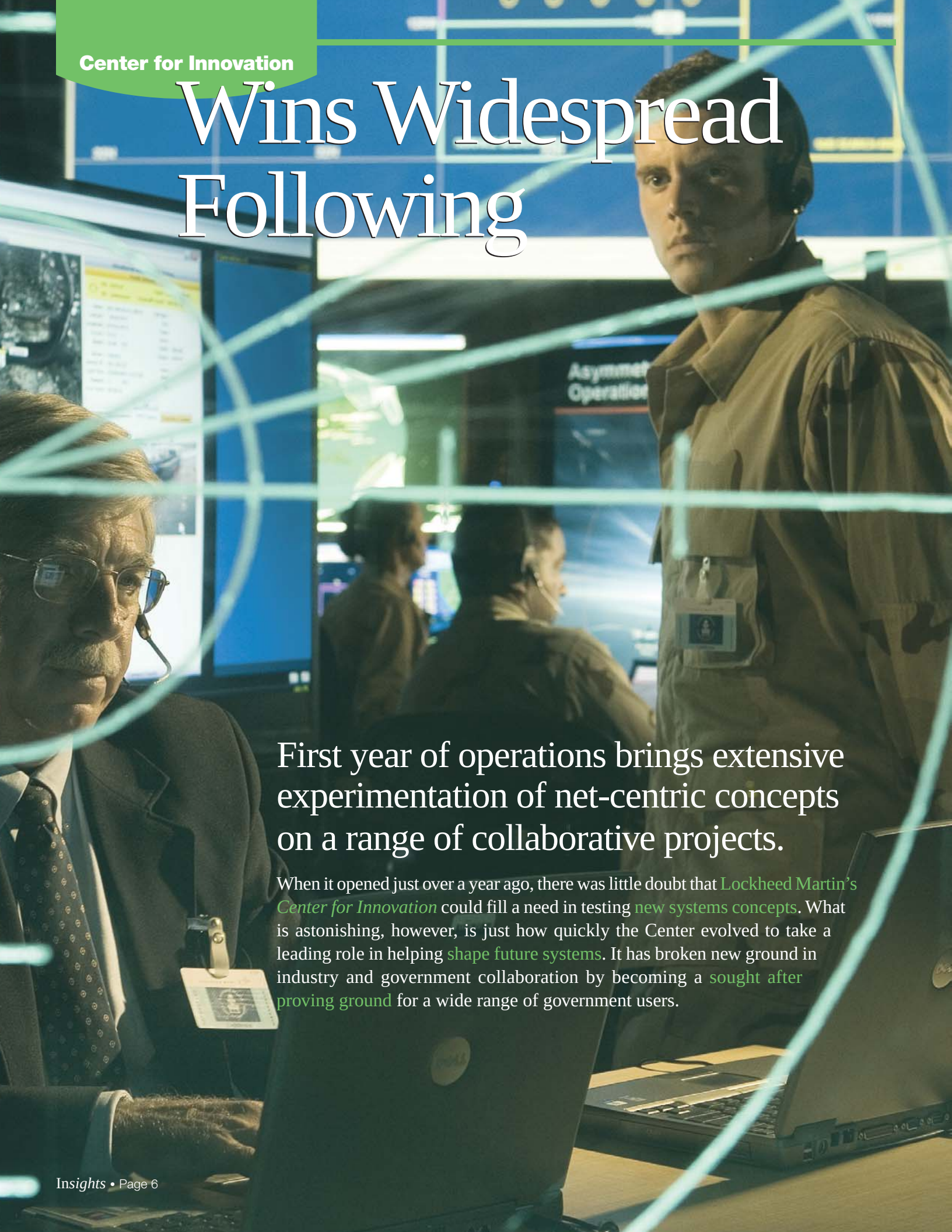
Wins Widespread Following



First year of operations brings extensive experimentation of net-centric concepts on a range of collaborative projects.

When it opened just over a year ago, there was little doubt that Lockheed Martin's *Center for Innovation* could fill a need in testing new systems concepts. What is astonishing, however, is just how quickly the Center evolved to take a leading role in helping shape future systems. It has broken new ground in industry and government collaboration by becoming a sought after proving ground for a wide range of government users.

Part of the Center's appeal rests simply in its well-designed work areas. Walk through the architecturally striking facility in Virginia's Hampton Roads area and you know that you are in a place that has been purposely designed as a working systems laboratory.

Lab areas, which the *Center for Innovation* staff calls sectors, rise two stories high and provide ample space for project teams to set up experiments. Networked computers provide building blocks for live and virtual collaboration with customers and to assess the impact of new systems as they are developed. It's exactly the kind of setting that can make it easy to visualize what happens, for example, in a simulation of a worldwide defense system or one designed to flag terrorist activities.

A Complete Command and Control Lab

The newest of the Center sectors houses a complete command and control laboratory. It's a multi-level reconfigurable lab spread over 6,000 square feet of space. In fact, the new sector is so fully outfitted that it was recently put to use by U.S. Joint Forces Command as the "Global Cell" command and control hub for the U.S. Army-Joint Unified Quest '06 wargame.

"When we opened the building, we left this laboratory space as a cold, hard shell. We asked our government customers what they needed to enhance their efficiency in developing command and control programs, processes and procedures," explains Buck Marr, the vice president of the *Center for Innovation*.

"The answer that came back was unanimous," says Marr. "They wanted a place where all stakeholders can collaborate during 'human-in-the-loop' exercises. So, as a result we tailored the command and control facility to be a place where the members of the defense establishment, commercial industry, U.S. government and coalition partners could come together and address the tough command and control challenges."

Collaboration During Unified Quest '06

While the week-long Unified Quest wargame was executed at the Army War College in Carlisle, Pa., the experimentation scenarios were distributed collaboratively among the Global Cell at the Center, the War College and other nodes. The wargame focused on improving concepts and capabilities to defeat irregular warfare challenges. It drew participation from the U.S. military and allied partners and representatives from the Defense Department and the departments of State, Homeland Security and other government agencies.

"To have the capability to provide the right environment for the Global Cell was a big advantage to us in conducting the exercise," notes U.S. Air Force Col. Terry Kono, head of Joint Command-Future experimentation support at Joint Forces Command. The use of the facility and analytical support available through the Center allowed JFCOM to expand on the Global Cell experiments and bring a greater focus to results, Kono says.

"The new command and control center is impressive, but what made it truly effective during the exercise was the ability to use networking technology to create a collaborative environment," adds Marr.

"It's this collaboration that brings together the human capital to solve problems that is one of the underlying thrusts of the *Center for Innovation*," Marr says. The environment is surely one reason the *Center for Innovation* has so quickly risen to prominence with customers. "We measure our success by the extent to which customers tap the value of this asset for collaborative development of solutions that advance our nation's defense capabilities and homeland security," says Marr.

Continued on Page 8.

> "The environment is surely one reason the *Center for Innovation* has so quickly risen to prominence with customers."

> "For *industry and government partners* alike, the COLLABORATIVE *thrust* represents an *entirely different* way of WORKING together."

Continued from Page 7.

Bringing Leverage with Intellectual Capital

For industry and government partners alike, the collaborative thrust represents an entirely different way of working together. For customers, these results can be described as adding leverage to the development process — leverage that comes from connecting to bright industry people and being able to focus intellectual capital on the front end of developing solutions.

Kono speaks of the boost in his group's productivity that has come from having access to the multiple capabilities of the Center. "We've been able to use the facility and draw upon Lockheed Martin's technology expertise in numerous events over the past year and involving hundreds of people."

The Joint Futures Lab has a mission of working closely with the services, other combatant commands and government agencies to develop and test new warfighting ideas and technology through co-sponsored seminars, workshops, experiments and wargames. Projects that have drawn upon the *Center for Innovation* have involved everything from strategic communications and the Defense Information Systems Agency, to joint urban operations.

The collaborative process received an added boost late last year with the signing of a cooperative research and development agreement, or CRADA, between Joint Forces Command and Lockheed Martin.

"Our recently acquired technology transfer authority provides Joint Forces Command with some attributes of a national government laboratory. This, in turn, allows us to partner with industry and other organizations in powerful ways," Kono explains. "Our new partnering agreement with Lockheed Martin, coupled with their new Center and their understanding of net-centric operations became a logical opportunity for both partners."

The result is that both sides now collaborate, through the CRADA, to turn out better solutions," says Kono. "It has enriched, accelerated and expanded the scope of our experimentation efforts."

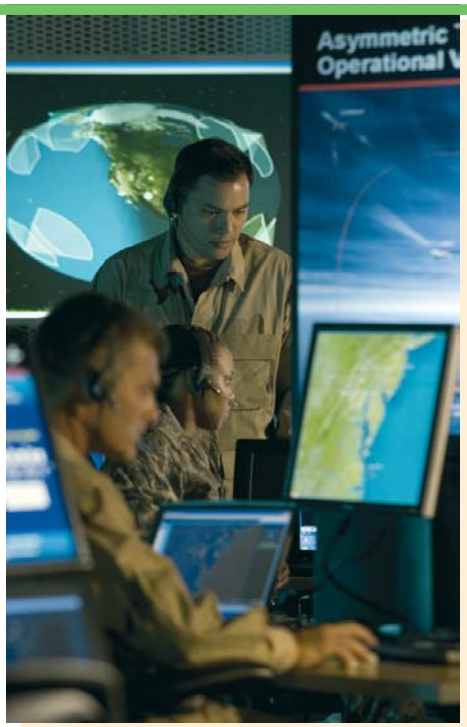
Government and Industry Both Benefit from Collaboration

This cooperative approach has benefits for both government and industry, Kono believes. Government gains valuable leverage on the experimentation process and industry gains greater insight into government needs. "We bring the warfighter's problems and an understanding of the capabilities needed. We bring the big problem that has been refined down to a specific solution that we're considering. Lockheed Martin brings its support network and scientific and technical expertise and industry perspective."

Will JFCOM look to extend collaborative work to other industry players? "We're looking at our interests and how other industry partners, as well as academia, might play a role. Tapping industry technology expertise as well as the intellectual expertise of academia is clearly a goal," says Kono.

The collaboration with customers that has become a hallmark of the Center's operations emerged far more quickly than expected. The *Center for Innovation's* initial phase — or spiral one — was intended to be as a demonstration facility that would then evolve into a laboratory for hosting experiments involving customers. Instead, experiments began to roll out just eight months after opening.

In all, the Center has worked on no less than 150 projects of varying size. "All of these emerging systems need a virtual or synthetic environment to be able to test their viability," notes Marr. "You wouldn't want to test systems like these for the first time on the battlefields of Iraq or Afghanistan. That's where our robust modeling and simulation capabilities come to play, providing the synthetic environment for evaluating solutions."



Center's Powerful Capabilities Prove Their Worth

Almost from the first days of its opening, customers have asked to use the *Center for Innovation* for experimentation to test new operational concepts. The Center has hosted more than 14,000 visitors who have come from both Lockheed Martin and customer commands, since its opening last year. Many of them have come with projects in hand.

A U.S. Navy experimentation team was one of the visitor groups. They spent several weeks last summer and fall on a prototype study of the Littoral Advanced Tactical System. That effort was to answer questions on how a net-centric system for ships might be architected and how the data generated should be managed.

Earlier this year, the *Center for Innovation* supported another major exercise in urban operations which helped better define systems for homeland defense.

Just recently, the Center served as host for a military wargame and a nodal analysis in support of U.S. Joint Forces Command. Both events examined the threat of improvised explosive devices.

To help prepare the way for customer projects, Lockheed Martin has also conducted some of its own experiments on using the Global Information Grid to distribute reconnaissance information and on a networked operational battle management system.

Located in the Hampton Roads area of Virginia, close to a number of military commands and others involved in government transformation efforts, the 50,000-square foot, high technology facility is ideally suited for work of operational analysis, experimentation and visualization.

Extensive Visualization

Using the Center's extensive visualization capabilities, project participants can see the various entry and exit points of a network environment and can participate as "humans in the loop" in live, virtual and constructive simulations. They can draw upon the facility's rich analytical capabilities to measure the operational results of system design decisions.

Global Information Grid Test Bed

The *Center for Innovation* — which also goes by its nickname, the "Lighthouse" because of the lighthouse replica within its atrium — also offers other powerful and unique support elements. It has a robust Global Information Grid test bed — the first of its kind within industry — which is used for rigorous evaluation of how systems solutions will operate on tomorrow's government network grid.

Collaborative Networking

Another vital capability paves the way for collaborative projects through networking. The Lighthouse is a key entry point to the Lockheed Martin Global Vision Network with links to high-end company laboratories performing systems experimentation and analysis as well as labs at government locations.

The encrypted and secure real-time network brings government developers and Lockheed Martin domain experts together online to work in live and virtual collaboration.

It's no wonder that this unique proving ground to assess new operational solutions in the fast-emerging world of global linked information networks has become such a popular new resource.

Industry *Brings Expertise*

To Pressing Intelligence Needs and Call for Information Sharing

Deborah Oliver
Deputy Vice President, Intelligence Programs
Lockheed Martin Integrated Systems & Solutions

Faced with protecting the country and its citizens against terrorist attacks, intelligence and homeland defense officials increasingly find they must harness the power of innovative technologies to help them identify and respond to potential security breaches and terrorist attacks. In fact, a sophisticated enemy may leave them only hours, or even just a few minutes, to make critical decisions and take appropriate actions.

The government agencies tasked with homeland security and intelligence responsibilities have acknowledged a greater need to improve how they share information among themselves and with the military services. Getting critical data into the right hands at the right time can save the lives of U.S. citizens here and abroad, the 9/11 Commission found. This new paradigm in national security, one that ensures the seamless marriage of intelligence and homeland defense operations, stems from Commission findings.

Under related reforms and government mandates, intelligence officials have been called upon to make sure they have the latest technological tools in computing, highly secure networks, reliable and adaptable software, the ability to share data with other agencies and also keep that information from falling into the wrong hands. They need horizontal, fully integrated systems that will allow real-time access to first responders in the field, and to ensure that important national security information flows all the way up to the highest levels of government — and even across national borders when necessary.

In addition, these open-architecture, enterprise-wide clients are looking for information technology providers who can anticipate their needs for future upgrades and who also can accommodate the migration of legacy systems and paper-based reports and records. And of course, a system that allows them to harness such key biometric profiles as retina scans, structural features, handwriting and voice recognition, could prove highly effective in thwarting planned or even opportunistic attacks.

This new mandate assumes the affected agencies, such as the CIA, FBI and Department of Homeland Security will have all the technology tools they need. But as the 9/11 Commission also discovered, each of the state, local and federal agencies have different protocols, privacy concerns and technological capabilities. Ironically, even key federal agencies like the FBI and DHS have not always shared information.

"Transformation Through Integration and Innovation"

Upgrading or installing new enterprise systems implies that a wide range of government operations will turn to the commercial sector for their growing information security needs. These IT professionals in turn will need not only to understand how the varying government departments operate, but how they fit into the overall system. This requires shifting transparently from extremely fine details to an overview of the entire national security apparatus, including organizations of the Defense Department.

President George W. Bush added significant impetus to this drive in his reforms of the nation's intelligence community. These changes provide the basis for the Intelligence Reform and Terrorism Prevention Act, which among other things, created the office of the Director of National Intelligence.

John Negroponte, the nation's first DNI, has made the use of technology the hallmark of his management. The director has alluded to the importance of information systems in releasing the National Intelligence Strategy with the tag line of "transformation through integration and innovation."

To be sure, the Negroponte report does not dwell on specific information management needs at various agencies. Nor does it refer to particular enterprise technology platforms. Instead, the document focuses on the country's broad intelligence needs and strategies, and Negroponte discusses the critical importance of sharing information on an enterprise-wide basis. He mentions how information must flow from a border agent, for example, all the way to the president. Failing to close these gaps, the director says, could give terrorists just the opening they need for a successful attack against the United States.

"Our strategy is to integrate through intelligence policy, doctrine and technology the different enterprises of the Intelligence Community," states the Negroponte report. It adds that "the Program Manager, Information Sharing Environment, will ensure the information needs of federal, state, local, and tribal governments and the private sector are identified and satisfied."

This is where the IT industry, and systems integrators in particular, enter the picture. Few if any of the various agencies involved in the overarching design will have the necessary professionals on hand to do this complex work in house. Instead, reflecting the government's desire to use commercial technology, they will turn to private vendors with deep expertise not just in technology, but also in the inner workings of the intelligence community.

Realignment Brings Together Intelligence, Homeland Security Expertise

Lockheed Martin has moved aggressively to ensure that it can meet its customer's growing intelligence technology needs, and recently completed a business realignment that mirrors the overall objectives of the nation's intelligence-homeland apparatus.

Continued on Page 12.

"*In this scenario,* making sure that *enterprise systems* ALLOW for *horizontal information flow* is more than just a buzzword. *It's ensuring our way of life.*"

Continued from Page 11.

By combining two of its business operations involved in intelligence programs and homeland security into a new business, Intelligence and Homeland Security Systems, the company will be better equipped to meet the ever expanding and dynamic needs of federal, state and local agencies responsible for guarding America against terrorism.

This new organization, I&HS, is uniquely suited to help homeland and intelligence agencies chart their technical futures. Though this business alignment is new, it builds on decades of experience in systems integration, data management, information security and analysis, enterprise architecture, wireless networks, system of systems and surveillance and reconnaissance.

Lockheed Martin has been working with the Department of Homeland Security since the agency's inception and has a strong understanding of the department's crucial need to share information with other intelligence organizations. The Corporation's businesses are working with DHS, as an example, to find ways to secure vital infrastructure, including water supplies, telecommunications, electrical grids, and oil and gas pipelines. We are engaged in ways to secure a financial and commercial supply chain that relies on electronic systems and protects them from incursion.

And by working closely with the FBI, Federal Aviation Administration, U.S. Coast Guard, Transportation Security Administration, Bureau of Citizenship and Immigration Services and many others, we have already developed a strong partnership in this arena. Then again, Lockheed Martin has been a part of the nation's homeland security effort since 1990.

Now, as we address 21st Century threats, industry has developed and will continue to produce new technology solutions that take into account the changing threat nature posed by an increasingly sophisticated enemy. At the same time, we can develop systems that allow information to remain secure against intrusions, such as those posed by malicious hackers including terrorists, while ensuring that data flows horizontally throughout the U.S. intelligence network.

It is this transparent flow of information that poses the greatest challenge for intelligence and homeland security organizations. Many of the hurdles stem more from history than from technology solutions themselves. That's because for decades many of the intelligence agencies have not customarily shared data with other organizations because of laws, customs or privacy concerns.

So, for system integrators it's not just about writing software or providing high bandwidth networks. Instead, it requires a thorough understanding of how a wide range of agencies will tackle their technology needs from different starting points, with varying levels of legacy systems, with diverse timetables, with distinct security needs and with varying uses of mobile and wireless devices. And yet, all of these

agencies and their individual departments need to communicate with each other or the nation simply won't have a coordinated terrorist defense.

Our customers are looking toward service-oriented architectures so that they don't end up duplicating their technology efforts as their missions change. The service-oriented architecture allows them to plug in applications that are necessary to serve their missions as they grow and take on new challenges. Customers also are looking to industry for knowledge management and knowledge creation solutions so they can look across a large repository of data and draw actionable intelligence from it.

In addition, intelligence and homeland defense agencies must have robust data storage capabilities. As they collect data, they need to archive it so they can easily access and analyze the information to draw critical conclusions. This aspect also implies high bandwidth, for some of the data could be three-dimensional models, biometric details, surveillance video and audio as well as cross checks of multiple criminal records flowing across multiple state or national boundaries — or all of this information combined. For the past 30 years, Lockheed Martin has repeatedly proven that it has a unique set of skills to meet the technology needs of government agencies that protect the nation's security interests. The technology revolution sweeping the intelligence and homeland defense communities presents exciting challenges and opportunities.

By working with state, local and federal agencies as part of a broad-based effort to thwart terrorism, we are providing a vital service not just to customers in the various government arenas, but more importantly to the American public as a whole. Our workforce understands all too well that the systems they create today may save hundreds or even thousands of lives tomorrow. In this scenario, making sure that enterprise systems allow for horizontal information flow is more than just a buzzword. It's ensuring our way of life.

Sentinel

FBI Looks to Streamline Data Handling

Improved information sharing could flow from enhanced case management

For the Federal Bureau of Investigation, a critical first step in promoting information sharing is to improve its handling of data, to make it easier to process information for its agents and analysts, and ultimately, for those who work with them.

To say that the FBI depends on huge amounts of data is by no means an understatement. An extraordinary range of data — from arrest and telephone records, photos, investigative reports, to biometrics, laboratory reports, evidence files — makes up the daily flow of investigative and intelligence activities.

Recognizing that information handling on this scale was a process that needed improvement, the FBI has named Lockheed Martin and its industry partners to the Sentinel project – an upgrade of its current systems, many of them paper-based. The agency's new priority mission of protecting against terrorism and foreign intelligence thrusts gives the effort added urgency.

"The events of 9/11 made it clear to our government and to our nation that we need to have a more efficient way of handling information," says Sandy Gillespie, the Lockheed Martin lead executive spearheading the company's focus on FBI support.

The FBI has stated that "the Sentinel project will transform the way the FBI does business and address the critical importance of timely and secure information exchange in order to protect national security." The program's challenges, Gillespie explains, have brought together several Lockheed Martin businesses to collaborate on the solutions that will be applied on this project.

Gillespie notes that the new system that will be developed as part of the six-year contract will deliver paperless information management and workflow, and also use web-based portal technology for investigative case management. This will provide a single point of entry to the data. As a result, agents and analysts will be able to more effectively and efficiently conduct investigations.

"Coming up with a 21st century approach to case management is a high priority," says Gillespie. Solving the Sentinel program challenges, she says, will give the FBI capability to better manage all elements that go into case activity, from investigations to intelligence and administrative activities. This should improve the time required to complete investigations.

The streamlined systems developed under the Sentinel contract are being designed in a way that will facilitate information sharing among law enforcement and the intelligence community. For example, Sentinel will use the "XML" exchange standard used commonly for document exchange.

Another feature is enhanced search capabilities which include a "Google™-like" resource and the ability to conduct advanced searches of a Bureau-wide global index of people, places, organizations, things and events.

These new services will also incorporate electronic records management and data warehousing techniques to capture and maintain pictures, video, biometrics and scores of other similar information.

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Data Fusion
Cuts Through the Clutter

Dr. Price Kagey
Director, Strategic Technology Center
Lockheed Martin Integrated Systems & Solutions

Anyone who has ever *jumped* out of an airplane *at night* and into a *battle zone* — real or simulated — understands all too well the concept of *sensory overload*.

Hurtling toward earth through the night sky, the gun-toting paratrooper quickly encounters a dizzying array of visual information from below — red lights, blue lights, yellow lights, white lights, strobe lights, flares, muzzle flashes from small arms and heavy artillery, not to mention helicopters and fighter jets buzzing the drop zone.

With so much visual chatter, it's easy for airborne troops to drift off course, perhaps even fall into enemy territory. In the dreaded worse case scenario, friendly forces can even mistake each other for the enemy and fire on their own troops.

Consider the modern digital battlefield. Today's commanders face a far more daunting challenge, one that might be considered an order of magnitude more complex, than a straightforward night parachute jump.

Indeed, ever since World War II the Pentagon has employed sensors and related hardware at a breakneck pace. In fact, the sheer magnitude of sensors combined with breakthroughs in computing power has helped make U.S. troops the world's most lethal warfighters.

Today's armaments are in fact both weapon platforms and sources of digital information. Fighter jets, bombers, cruise missiles and unmanned aerial vehicles all fly to their targets armed with an array of sensors that provide vital real time information.

Even troops have become moving digital sensor arrays, giving their commanders ears and eyes on the ground with their ubiquitous radios, night vision goggles and camera-equipped helmets. Meantime, acoustic sensors deployed to detect enemy troop movements provide information as satellites are beaming high-resolution photographs and video images.

Data Fusion: Reliable Information

The sheer volume of information available today combined with the breakthroughs expected in the next three to five years threatens to overwhelm senior commanders. With so much information coming from so many sources at the same time, how do these leaders cut through the clutter and make the correct decisions that inflict enemy casualties while minimizing destruction of friendly forces?

Enter the burgeoning field of computer engineering known as data fusion. Simply stated, the field seeks to use intelligent software to fuse all sorts of disparate data and break down information into discrete actionable items. Of course, this is much easier said than done.

And data fusion is the necessary reaction to the double-edged sword known as Moore's Law. Originally, the law as espoused by Intel co-founder Gordon Moore 40 years ago stated the number of transistors per square inch on integrated circuits would double every 12 to 18 months. Now, however, computer experts speak of this dictum in terms of data density, and every 18 months it doubles.

In a very real sense, data fusion is needed to make the most of the ever-advancing onslaught of sophisticated sensors. That's why many experts often describe the field as "multi-sensor data fusion." Think of it this way: sensor technology grows geometrically but software advances only arithmetically. Data fusion seeks to close this information gap.

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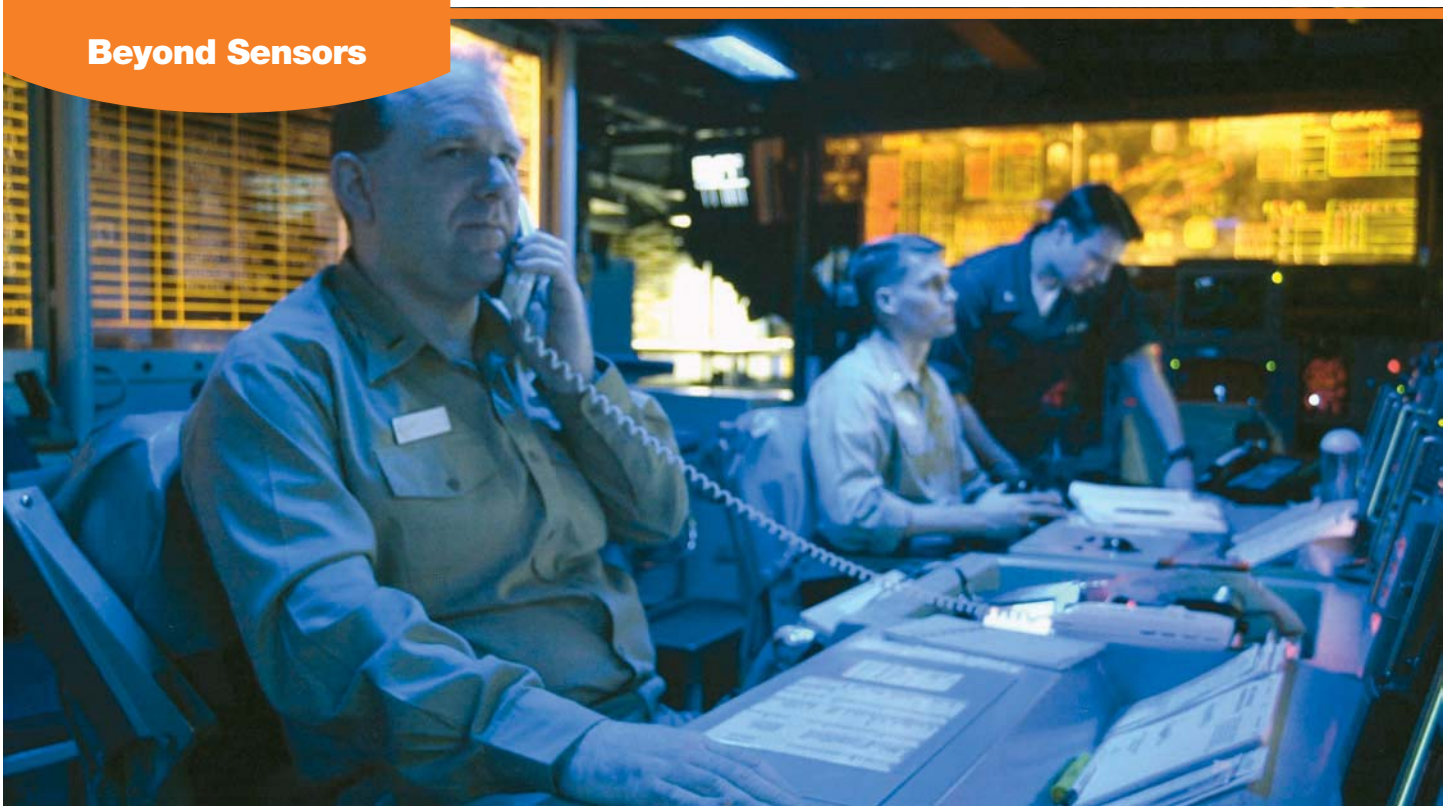

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Industry-Leading Technology

Lockheed Martin has made advanced data fusion technology a major priority and has a distributed work force continually tackling the field's toughest problems. In 2003, Lockheed Martin acquired the former Orincon business, a San Diego defense and information technology firm with a veteran data fusion team, and renamed it Advanced C3 Development and Integration.

Lockheed Martin proved it has one of industry's leading tracking and fusion technologies following a series of elite government-sponsored simulations involving the U.S. Navy's future surface combatant ship, the DD(X).

The test was arranged to track aircraft, ships, submarines, and land targets, and was based on a number of simulated multi-warfare scenarios. Quantitative measures of data fusion performance were evaluated across a range of scenarios that incorporated data from five different sensors.

Only Lockheed Martin's data fusion technology proved capable of processing the sensor inputs fast enough to have a fully integrated operational picture available at all times. It was the only tracker to perform equally well across all warfare areas and in real time.

Responding to Challenges

Real time management of critical battlefield data serves as the Rosetta stone of data fusion. The overarching concept is to integrate a suite that could total dozens of input variations into one overall picture that would be displayed into a meaningful depiction of the actual "battlefield," including what's happening at sea and in the air.

Without data fusion, U.S. forces will find it difficult to fully exploit all sources of data — acoustic, infrared images, video, human intelligence, radio intercepts, maritime signals, and friend or foe technology. Ironically, in no small measure do advances depend on overcoming the difficult challenge of writing better, faster and more accurate algorithms.

These detailed sets of software instructions are often taken for granted but shouldn't be. For instance, the set of instructions sent by the human brain to find, acquire and eat food results from automatically generated algorithms refined over centuries of evolution. If one step in the sequence goes wrong that juicy hamburger may not make it to your mouth, but to your lap instead.

So it is with data fusion. If the software used to identify, track and ultimately fire on a target contains even a small bug, then we could accidentally shoot down a friendly rather than an enemy jet. Thus, cracking the data fusion code with ever better algorithms is a goal of the entire defense intelligence industry, and Lockheed Martin has nine different work groups focused on various aspects of data fusion as well as testing the results at the company's net-centric laboratory, the *Center for Innovation*, in Virginia's Hampton Roads area.

As it relates to the warfighter and to homeland defense, data fusion could significantly affect five main areas:

The Digital Battlefield. Linking all these sensors together to provide real time information will be split into two broad arrays: hub-and-spoke-information for tactical units that need limited information transmitted via radio, and hierarchical data that can harness fiber optic technology for robust warfare information.

Robotic and Automated Vehicles. These could be airborne or land-based as in the case of a land-based robotic vehicle, the "MULE," that Lockheed Martin is developing for the Future Combat System. Robot vehicles can be used for dangerous and repetitive tasks, such as clearing mine fields and delivering supplies under fire.

Supply Chain Management. Mirroring the commercial transport industry, virtually every single piece of gear in the U.S. military can be tagged and tracked to ensure that all supplies vital to victory are delivered at the right place and the right time.

Friendly Fire. Friend or foe identification has been a long-term goal of sensor technology and this is improving. But with data fusion, friendly forces could send continuous encrypted signals to make sure they are not accidentally acquired and targeted by the enemy.

Homeland Security. By harnessing data fusion, homeland defense officials could further secure U.S. borders with predictive technology. A government-funded program known as PANDA seeks to use predictive technology to warn the Navy and U.S. Coast Guard of unusual maritime movements that may indicate terrorist-related activities.

A data-fusion related program, PANDA stands for Predictive Analysis for Naval Deployment Activities. PANDA, which includes work by Lockheed Martin, seeks to automatically identify new threats by searching for even the subtlest clues among thousands of ships at sea.

Thus, data fusion eventually will have a pervasive impact on both battlefield capabilities and homeland security. Harnessing continued breakthroughs in sensor technology with computer power that predicts enemy or terrorist activities would ensure not only that U.S. forces remain the most advanced in the 21st Century, but also would help the Pentagon get the maximum — and most intelligent — use of its defense technology dollars.

Five Levels

The complex and emerging field of data fusion is broken down into five key areas in ascending order of intelligence. Below is a look at each of these levels as they relate to defense applications.

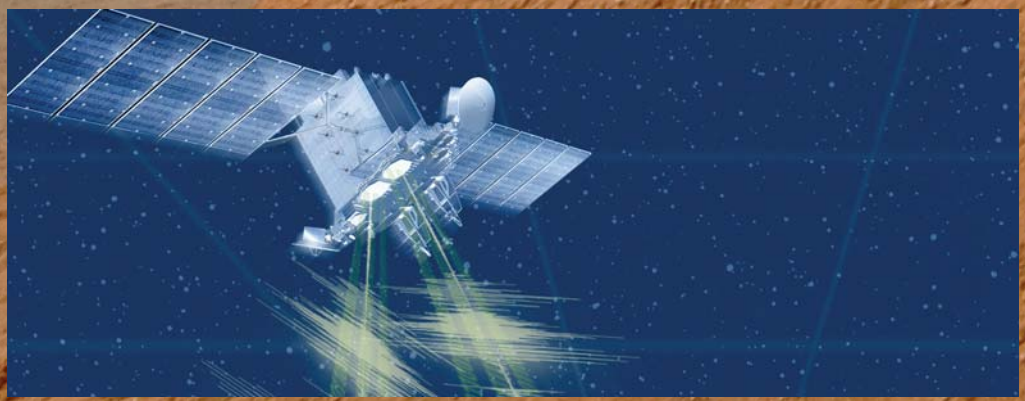
It is clear that as the system invokes higher levels of fusion the computational techniques that are required move from rather straightforward track estimation, threat counting, and classical statistics to a combination of knowledge-based, symbolic, and information theoretic techniques; basically, this is a move toward "machine intelligence and cognition."

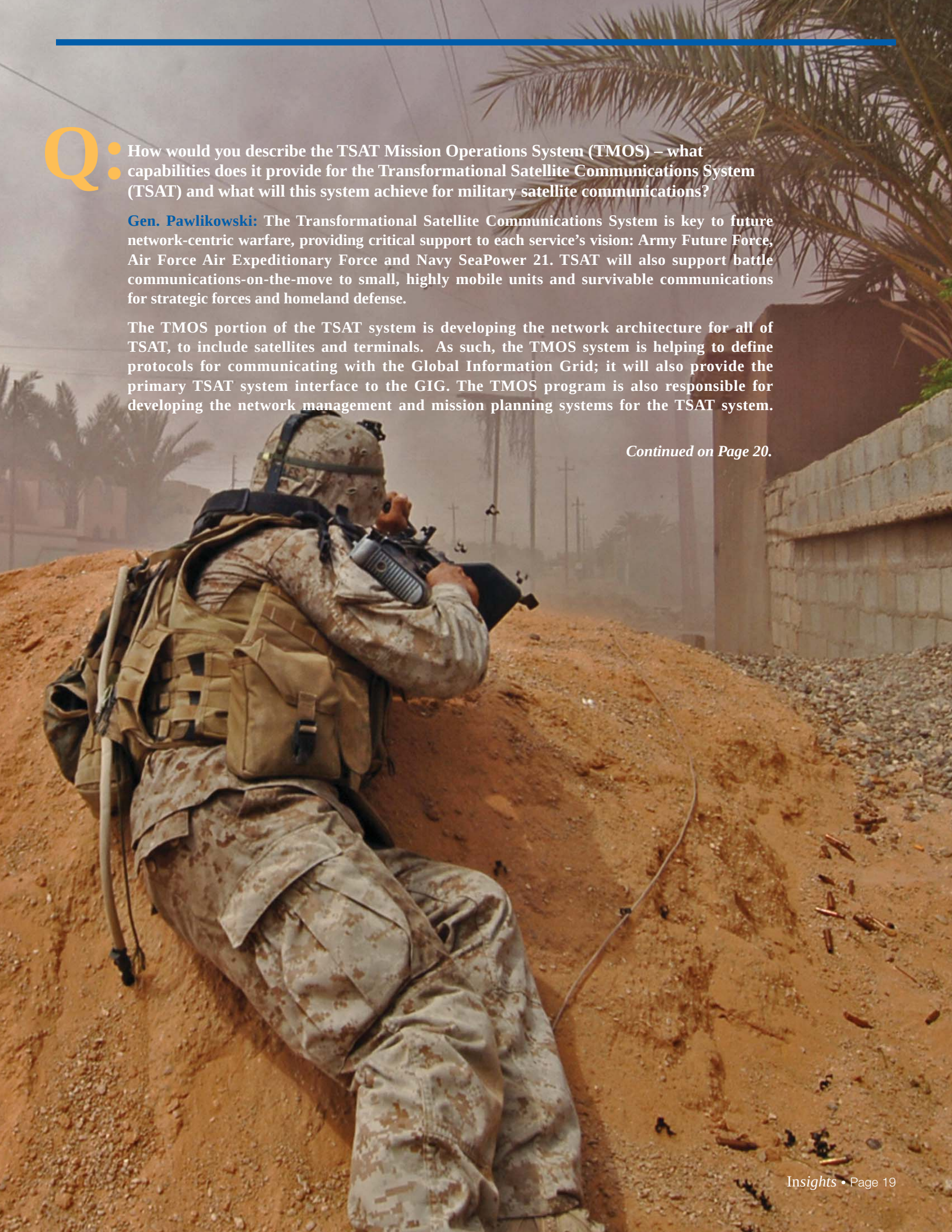
Level 0:	Target location and identification: Basic level looks at tank vs. truck; fighter vs. cargo plane; MIG-29 vs. SU-15, etc.
Level 1:	Target track estimation, prediction, and association: Examines the direction of specific targets and where they will be at the next update; proper correlation of tracks seen by multiple sensors.
Level 2:	Situation refinement: Estimates target clustering and relationships to include cross-force relationships; situational awareness increasing.
Level 3:	Impact assessment and intent: Estimates threat force intent coupled with threat estimate refinements. An example would be in providing situational understanding to support a flanking movement that will be developing as RED enemy forces coalesce.
Level 4:	Resource management: Real time, adaptive management of sensor systems and other resources. As an example, this could involve moving unmanned vehicles to better positions to track forces as they move through mountainous areas.

Cornerstone *for Transformation*

Brig. Gen. Ellen Pawlikowski, Program Director, U.S. Air Force, MILSATCOM Joint Program Office

As the program director for the U.S. Air Force MILSATCOM (military satellite communications) Joint Program Office, Brig. Gen. Ellen Pawlikowski heads the Air Force's efforts to develop the Transformational Satellite Communications System — TSAT. This advanced Air Force network will provide a new level of high-bandwidth, secure, global communications to transform the speed of command and supply a vital information link to deployed mobile forces. Gen. Pawlikowski discusses TSAT's role in net-centric warfare and progress in the development of the TSAT Missions Operations System, which will provide the network and operations management segments for the TSAT system.





Q How would you describe the TSAT Mission Operations System (TMOS) – what capabilities does it provide for the Transformational Satellite Communications System (TSAT) and what will this system achieve for military satellite communications?

Gen. Pawlikowski: The Transformational Satellite Communications System is key to future network-centric warfare, providing critical support to each service's vision: Army Future Force, Air Force Air Expeditionary Force and Navy SeaPower 21. TSAT will also support battle communications-on-the-move to small, highly mobile units and survivable communications for strategic forces and homeland defense.

The TMOS portion of the TSAT system is developing the network architecture for all of TSAT, to include satellites and terminals. As such, the TMOS system is helping to define protocols for communicating with the Global Information Grid; it will also provide the primary TSAT system interface to the GIG. The TMOS program is also responsible for developing the network management and mission planning systems for the TSAT system.

Continued on Page 20.

Continued from Page 19.

Q: Why is the TMOS system considered to be transformational and how will it change the way we fight wars, from the decision makers to the soldier, sailor, airman, in the battle zone?

Gen. Pawlikowski: The TSAT system is transformational because of its use of new technologies, such as laser communications — "lasercom" — advanced radio frequency waveforms, dynamic bandwidth allocation, and internet-like packet switching. These technologies enable the TSAT constellation throughput to be roughly 10 times (10x) that of the Advanced Extremely High Frequency satellite constellation. Additionally, the TSAT system will also enable support to mobile user technologies and to intelligence, surveillance and reconnaissance platforms.

The TMOS component is also transformational because it must provide network management and mission planning for the services and technologies that I previously mentioned. This includes the development of a distributed TMOS system architecture, and a substantial evolution from past commercial and military systems. In addition, the TMOS network management system will use a policy-based system to provide guaranteed services for users.

Impacting the GIG

Q: How will TMOS help the Department of Defense realize the full potential of the Global Information Grid?

Gen. Pawlikowski: TSAT puts the "global" in the Global Information Grid, enabling real-time net-centric connectivity of all GIG assets, such as sensor-to-shooter capabilities, and establishing worldwide persistent connectivity of high-low resolution for space and airborne ISR assets.

Early TMOS system definition, which we are engaged in now, allows for development and horizontal integration with other GIG systems. We will also define the network standards and a set of standardized interfaces for network management and mission planning as part of the Net-Centric Implementation Documents. These networking products are the cornerstone to the future MILSATCOM architecture and its interface with the GIG.

Ultimately, the TMOS system will manage the TSAT satellites and terminals to provide users — who cannot connect directly to the GIG — circuit and packet services, as well as access to information that is available through the network.

Q: Would you comment on the concept of 'Policy Based Network Management' and what importance it has for the TSAT system?

Gen. Pawlikowski: Policy Based Network Management is the use of a policy framework to make network management decisions based on pre-determined rule sets. It includes the definition and distribution of policies, as well as functions to manage policy. In response to sensed changes in warfighter's satellite communication needs, lower level policies can adjust configurations to control the network to better achieve the superseding hierarchical policy's goal.

TMOS' implementation of this policy framework will provide the TSAT network and its users with the rule sets and automation that are needed for dynamic, responsive warfighter support and the effective implementation of command direction.

Risk Reduction Targets

Q: The Congress cited technology risks in reducing the TSAT program budget request for FY04-06. How has the U.S. Air Force responded to those concerns?

Gen. Pawlikowski: The TSAT program defined technology readiness on the risk reduction path to flight with space segment contractors for six specific key technologies: single access lasercom, bandwidth efficient modulation, Dynamic Bandwidth Resource Allocation, Communications-on-the-Move Antenna, TRANSEC (Transmission Security), and Space High Assurance IP Encryptor. Within the program's congressionally-directed budget reductions, these six technologies continue to make solid progress.

To ensure that the technologies are appropriately matured prior to production decisions, the government has adopted a technology readiness approach, in which heritage experience and flight experiments are leveraged by competing contractors to build breadboards and brassboards that are tested in government independent assessment test beds.

In traditional space acquisitions, critical technologies are expected to achieve "Technical Readiness Level" (TRL) 6 on a 9-level scale by system preliminary design review (FY09 for TSAT). For the TSAT program, three of the critical technologies have already achieved TRL 6, and the remaining three critical technologies have already achieved TRL 5 and are projected to be at TRL 6 by the system design review stage in FY07, nearly two years ahead of typical programs.

Q: Congress is reviewing the FY07 budget request now and early indications are that the technology concerns have been addressed. How did the decision to proceed with the TMOS program help this process?

Gen. Pawlikowski: While we have focused on technology development congruent with congressional concerns, the decision to proceed with development of the TMOS program was not directly based on the progress in the areas of technological concerns. The continued development of the TMOS program was necessary for the purpose of synchronizing the program in line with the TSAT system acquisition strategy.

The TMOS network architecture and design is the cornerstone of the MILSATCOM-GIG interface. The award of the TMOS contract allowed the detailed work on the network architecture to progress.

The network definition is critical in defining the capabilities that will be required on the satellites, and it's being accomplished in conjunction with the space segment contractors and representatives of the terminal programs. This effort helps reduce risk to the overall program and the space segment source selection.

Innovative Practices, Acquisition Steps

Q: It has been reported that the TMOS program just recently completed its system requirements review milestone. Would you comment on how the program is progressing and what challenges you see in the future?

Gen. Pawlikowski: The TMOS system requirements review indicated that the TMOS contractor has a good understanding of the overall segment requirements and that the initial baseline is sufficient to proceed with an initial design. The review was very well attended and included representatives from Air Force Space Command, users, terminal programs, DISA (Defense Information Systems Agency), the Office of the Assistant Secretary of Defense-Networks and Information Integration, and both space contractors, among others.

The review did point out areas where more effort is needed to refine the current requirements, and it will not be officially closed until these areas have been worked. Overall, the TMOS system development is progressing as needed to support the overall TSAT program.

The biggest near-term challenges will be in cooperatively developing a network architecture that can be implemented by the TMOS system and the space and terminal segments.

Continued on Page 22.

"TSAT puts the *'global'* in the Global Information Grid enabling *real-time* net-centric *connectivity* of all GIG assets..."

Continued from Page 21.

Q: The Air Force Space and Missile Systems Center and the MILSATCOM Joint Program Office are always improving their acquisition practices to maximize mission performance, cost effectively and predictably. What were some of the innovative practices employed in the TMOS procurement and what other changes do you see in the future?

Gen. Pawlikowski: There were several innovative practices used during procurement. TMOS continued several best practices from previous acquisitions including the use of multiple draft RFPs and Industry Days to solicit industry input into the process.

In the software estimation area, there were detailed discussions regarding commercial technology usage and estimation during the program research and development announcement phase that allowed for improved cost fidelity during the source selection. In addition, detailed data on software code size was required, as well as the costs for risk mitigation.

Another best practice was to include a focus on team-wide processes. This was done using three different techniques. The first two related to the Capability Maturity Model Integration (CMMI) Level 3 requirements. We included a contract clause to require a team-wide standard CMMI appraisal method for process improvement — to include systems engineering and software — within nine months of the contract award. This clause also allows the government to perform an independent appraisal at any time during the contract.

The second CMMI best practice was to include a requirement that looked at how the contractor planned to implement CMMI Level 3 software engineering standards across their entire team. The third best practice was to use a software development capability evaluation as part of the source selection to evaluate contractor

> "The TSAT system will also enable SUPPORT to mobile user *technologies* and to *intelligence, surveillance* and *reconnaissance* platforms."

> "TSAT network... needed for *dynamic*, responsive *warfighter* SUPPORT and the effective implementation of COMMAND *direction*."

software development processes and maturity in specific areas of interest to the source selection evaluation team.

Another innovation was to develop specific data rights clauses as part of the source selection process. This included defining very specific data products needed for the TSAT program and specific organizations that would need those rights, such as other TSAT contractors, future maintenance contractors, and depot personnel. Specific rights for each organization were spelled out and contractors proposed the cost to provide those rights on all new and reused software.

Another best practice was in the area of past performance. Very specific past performance matrices were developed to consolidate and facilitate the past performance assessment for each of the major source selection evaluation factors.

These matrices highlighted the types and combinations of past performance that would provide the highest relevancy ratings for the past performance factor. Additionally, a checklist was developed and used from the Air Force Material Command past performance guide to ensure that the team completed and evaluated all required items.

We also followed the best practices of requiring the proposal to include resumes of at least 35 key personnel and then requiring a commitment to allocate at least 80 percent of their time to performing the effort for the first three years.

BIOGRAPHY

U.S. Air Force Brig. Gen. Ellen M. Pawlikowski is director of the Military Satellite Communications Joint Program Office, Space and Missile Systems Center, Los Angeles Air Force Base, Calif. She directs acquisition planning, programming, budgeting, execution and congressional activities for a $46 billion portfolio for military satellite communication systems.

These systems include the: Milstar constellation, Defense Satellite Communications System, Wideband Gapfiller Satellites program, Advanced Extremely High Frequency program, Transformational Satellite Communications System program, Global Broadcast Service program, Command and Control System-Consolidated program, and associated Air Force communication terminals and mission control systems.

She exercises the authority of the Air Force Program Executive Officer for Space in interacting with the Office of the Secretary of Defense, the National Reconnaissance Office, NASA, the National Security Agency and major commands.

Gen. Pawlikowski has served in a variety of technical management, leadership and staff positions, and has also served as deputy assistant to the Secretary of Defense for Counterproliferation. Prior to her current assignment, she was director, Airborne Laser System Program Office, Space and Missile Systems Center, Kirtland Air Force Base, N.M.

She earned a doctorate in chemical engineering from the University of California-Berkley.

New Threats

Demand Ability to Develop Strategies, Tactics More Quickly Than Ever

One need only look around. Practically everything in sight is a potential terrorist target: fields of grain, sports stadiums and arenas, cruise ships, a telecom switching hub, campus buildings.

And just as many might also be weapons: a cargo ship, aircraft — from airliners to crop-dusters — that unusual cloud drifting overhead or an electromagnetic device. Of course, military people and materiel are targets for terrorists or rogue states, and over the past 15 years, the types of potential attacks have burgeoned and diversified. Defensive responses must react in kind — and do the job right, often in only minutes.

Developing innovative strategies and tactics is more complex and more crucial than ever before. Any new mission, whether its goal is to detect and respond to a poisonous cloud, intercept a Scud missile fired at a densely populated area, or disable devices that could crash telecom and data networks, requires intensive conceptual and practical systems engineering. And that's the role of the OMEGA™ Framework for systems engineering and integration, or SE&I, offered by Lockheed Martin.

In the simplest terms, the OMEGA Framework is Lockheed Martin's branding of the SE&I capabilities that it provides to customers to solve a wide and diverse array of challenges affecting military commanding, joint operations, logistics, homeland security and much more. This framework is the embodiment of intensely trained and highly skilled engineers following well-defined and repeatable processes, operating a large array of commercial and government "off-the-shelf" systems and internally developed tools to integrate and evaluate system solutions for our nation's defense.

The OMEGA Framework offers 11 areas of competence that span the acquisition and program life-cycle. "We typically don't bring all of the competencies into play on a given project," says Lockheed Martin's Gerry Bartkowski, a principal systems engineer. "They're more like an a la carte menu — we select only those that are needed to solve a customer's problem."

Capabilities Based Assessment Framework

One commonly used OMEGA technique is called the "capabilities-based analytical framework," or CBAF. This approach takes customers through a set of steps to rigorously analyze their needs and devise alternative ways of meeting them. "We narrow down the trade space of alternatives, using a variety of techniques. We perform more in-depth simulation and analysis of them to gain a balanced portfolio view of cost, schedule and performance outcomes. The resulting recommendation that we produce offers a best-value solution," says Bartkowski. Additionally, Lockheed Martin STASYS' iSMART interoperability process and toolset has been integrated into the OMEGA Framework to provide comprehensive insight and analysis of interoperability issues, and to ensure smooth operation of multi-system solutions.

The CBAF is comprised of the following analytical elements:

Value Engineering. A decision analysis approach that links possible solutions to a mission's capability needs and the investment strategy using a well-defined analytical model.

Integrated Architecture Development. Operational- System- and Technical-view products required to completely capture an enterprise-wide solution perspective that is driven by mission needs.

Interoperability Assessments. Comprehensive analysis of integrated architectures that determines the net-readiness of systems and families of solutions.

Executable Architecture. A dynamic simulation approach that demonstrates behavior and also promotes visualization of a user's concept of operations, or ConOps, that is derived directly from integrated architecture solutions.

Operations Analysis. Conduct and deliver quantifiable data – technical, cost, schedule and risk-based performance data — for decision making purposes.

"The power to trace recommended solutions back to stakeholder wants and needs are clearly evident," says Bartkowski. "This can be powerful evidence to justify program acquisitions and for the development of ConOps by military chains of command."

Continued on Page 26.

"There are always a *number of ways* to SOLVE a problem, and the *alternatives* DEFINE the *limits and variations* of possible SOLUTIONS."

Continued from Page 25.

First, Define the Goal...

The first step is creating a value model — scorecard criteria for evaluating mission performance. This is where mission goals and objectives, high-level measurements, scenarios — anything and everything that clarifies the goal — are brainstormed and discussed. "At this stage, our people engage intensively with the customer, including all stakeholders, through a number of discussions as we define and refine what they need," Bartkowski says.

Then, Consider the Alternatives...

After analyzing all elements of a customer's goal, the systems engineering team develops a number of integrated architecture solutions, ranging from relatively simple to very complex. There are always a number of ways to solve a problem, and the alternatives define the limits and variations of possible solutions.

Also in this stage, the team collaborates with users and proposes a set of detailed tests — or experiments — for evaluating proposed architectures and gains their acceptance of the approach. The scenario must be realistic to gain stakeholder confidence in analytically-based results that will translate into successful operational effects.

Once various possibilities are evaluated, the most promising solutions are taken to the next stage: an executable architecture. "The integrated architecture is static, sort of a snapshot in time," states Jason Loveland, a Lockheed Martin systems engineer supporting CBAF efforts at Lockheed Martin's net-centric laboratory, the *Center for Innovation*. "It visually illustrates how a ConOps is dynamically executed by operators and users in realistic situations and environments." Lockheed Martin's modeling and simulation capability may include hardware and operator-in-the-loop elements to gain a "drive before you buy" perspective from stakeholders, well before they would be acquired and deployed to the field.

Customers see all of the action and interaction — just as it will occur — on a ConOps simulator developed by Lockheed Martin, Loveland says. In the missile attack example, the ConOps simulation can demonstrate radar components, their interaction with other detection systems and the ability to quickly deliver data about the oncoming missile to command and control operators.

"Being able to see just what happens, and when, is very powerful for executives, generals, managers and engineers," Bartkowski adds. "Often, goals or requirements are revised at this stage."

Interoperability Assessment

Another very important component of the CBAF is the crucial interoperability analysis. If systems can't talk, actions don't happen. Interoperability has already been considered as part of the integrated architecture and again as part of the executable architecture. But now, using the iSMART process, the assessment goes into deep granular detail.

"iSMART enables us to document in a repeatable and rigorous way information requirements for each component of the solution, and also how each can transfer information to others," says David Barnes, senior consultant at Lockheed Martin STASYS.

The iSMART analysis looks at not just the protocol each system uses to transmit data, but also the specific implementation of that protocol, the method of encryption, even sometimes at the packet format, if the data is encoded in packets. It compares this information for each pair of systems that must interact, looking for incompatibilities.

Information exchange between systems has been historically very difficult to analyze, he points out, in part because the requirements for data exchange are often rolled up with other requirements and not described separately.

And, of course, there are the myriad formats, protocols, and communications links developed by the different services and by the militaries of different countries.

STASYS has used the iSMART process for customers from Europe and other regions as well as from the U.S.; it can check for interoperability among them, for example, whether a given system from the U.S. can communicate with another from NATO.

The Best-Value Solution

Whether the architecture works from a mission or campaign perspective is determined by conducting an operations analysis. Does it have inherent limits? Do any components need hardening or protection from high heat, for example? Risks, also, are analyzed. Are new systems being used? How thoroughly have they been proven? So is availability. What's on the shelf now, and when will new components be ready? In addition, this stage evaluates cost in terms of the customer's goal. The chosen architecture might give the best performance, but be too expensive — perfectly functional with five satellites in the sky, but not so if the customer has only two.

All of the analytical efforts finally come together with a comprehensive decision analysis effort. “Finally,” Bartkowski says, “we feed all the information we’ve developed back into the customers’ value model, as part of the decision analysis work, to determine the best-value solution. Given the priorities, given the architecture and its verified performance, is this the best value for the money? If we and the customer don’t think so, we go back through the earlier steps and test out another concept.”

“The OMEGA approach for addressing customer challenges is collaborative, data-driven and cost-effective,” says Terry Kees, Lockheed Martin’s lead executive for the OMEGA Framework. “Stakeholders are able to assess possible solution options and validate that the capability needs can be realized well before an acquisition is executed. They see and understand upfront the risks, trade-offs and benefits of each course of action, and are poised to make a well-informed and defensible decision.”

The OMEGA Framework demonstrated in programs and venues like the *Center for Innovation*, and now augmented by the iSMART capability, offers the most comprehensive process for systems engineering in the industry, staffed by domain experts and system integrators, for finding best-value solutions. This approach is based on over 35 years of system engineering experience, decades of modeling, simulation, and analysis expertise for air, space, communications and ground systems. Its hallmarks are heavy operator and engineer interaction and collaboration throughout the lifecycle, using effects to drive investment decisions, architectures, ConOps and system interdependence.

The Network Is Central

iSMART

A system of systems is, of course, a network, and the iSMART process’ task is to make sure it behaves like one. End-to-end system interoperability is necessary — and very difficult to achieve, given the number of vendors, armed services, legacy and new systems, proprietary and open ones, and versions, updates, and implementations.

To assess interoperability, the iSMART process relies on the experience of its engineers and on proprietary tools. It also relies on strictly defined analyses of protocols, formats, links, and other properties of proposed systems.

“iSMART demands that you express system requirements in an engineered, hierarchical way,” says David Barnes, senior consultant at Lockheed Martin STASYS. These specifications must have at least four elements: the sets of requirements imposed by multiple systems and defined per each individual system; information to be exchanged and with whom; and the platforms to be used. It may also include constraints, such as a requirement for a certain type of encryption, or that communications must extend beyond the line of sight. “Once this information is spelled out, the process becomes fairly mechanical — something our computer-based tools can execute.”

Automating the process prevents the inevitable human error, as well as eliminating re-keying data, since the tools interoperate with each other. The toolset, called e-SMART, includes:

- **eIER**, the Information Exchange Requirements assessment tool, now being integrated with OMEGA™ Framework tools;
- **eDoc**, a documentation tool that allows the team to specify the implementation of particular communications media, and;
- **eBit**, a tool that specifies the exact details of values in specific fields that are necessary to transmit or receive information between given systems, and the outcome of those received.

The toolset gets so specific that it unpacks each data communication, even looking into packets, if that’s how the data are organized. This fine detail can reveal hard-to-detect problems and potential interoperability issues.

Barnes cites an example of two fighter aircraft on mission together, but lacking the same implementation of onboard software. Both fighters receive incoming data on a target they are tracking. The first fighter is able to accept and process all of the data; the second fighter, with a different version of software, cannot process certain elements of it. In this scenario, the iSMART analysis capabilities can be brought into play to determine consequences of the situation. Will the second fighter be able to acquire the target, despite its software handicap, and will the mission succeed? Moreover, Barnes explains, iSMART’s ability to unpack the full load of data enables it to answer a range of “what if” questions the customer could pose — “Can I perform additional tasks not in the original requirements, and what would the effects be?”

The iSMART process doesn’t just ensure interoperability. It underpins flexibility that enables customers to respond much more nimbly to quick-changing terrorist threats in particular, Barnes says. And that flexibility can also make the process of changing military tasks — say, from fighting to peacekeeping — much easier and more efficient.

UK Swift Experimentation Lab to Study Network Enabled Capabilities

Lt Gen Sir Robert Fulton KBE (right) observes a demonstration from Lockheed Martin's Charlie Morrison, missions officer, Geospatial Intelligence Solutions.

Lockheed Martin has opened a state-of-the-art laboratory and experimentation facility in Farnborough, England, where it will collaborate with customers to develop solutions that address their emerging threats and operational challenges using network enabled capabilities.

The reconfigurable facility is called "Swift" because it will be used to rapidly prototype solutions to complex problems. Located in the Farnborough Aerospace Centre, the Swift lab enables Lockheed Martin and its customers to run detailed and realistic program analysis in a network enabled environment.

The Swift lab facilitates the rapid testing of new operations and scenarios through realistic "stressing" of systems and the simulation of a bandwidth-constrained environment. It is an industry-unique facility to test and evaluate transformational capabilities such as multi-intelligence information fusion, intelligence, surveillance and reconnaissance mission management, integrated situational awareness and battlefield visualization.

Through the facility's advanced technical capabilities, Lockheed Martin will respond to its customer's growing requirements for network enabled capabilities that improve interoperability, and develop transformational effects-based solutions.

Swift lab enables technology sharing and collaboration on integrated, networked solutions across multiple Lockheed Martin advanced laboratories, including the Corporation's flagship laboratory, the *Center for Innovation*. Being networked to the company's U.S. labs will help enhance cross-Atlantic exchange of ideas, technical competencies and domain expertise with experts in the U.S.

> "The *reconfigurable facility* is called "SWIFT" because it will be used to RAPIDLY prototype *solutions* to complex problems."

Lockheed Martin Acquires Active RFID Supplier, Savi Technology

Lockheed Martin has acquired Savi Technology, a provider of active radio frequency identification, or RFID, solutions. The purchase enhances Lockheed Martin's capabilities in global focused logistics.

Savi brings highly developed expertise in active RFID and other logistics technologies, networks and systems that enable customers to automatically identify the contents of shipments and track the location and status of supply chain assets.

Savi, based in Sunnyvale, Calif., has developed innovative logistics solutions that track in-transit asset shipments in a secure, accurate and timely manner.

- Its full line of hardware and software products have been implemented by the Department of Defense, international defense agencies, civil agencies and commercial enterprises to monitor cargo shipments globally.
- Savi's products include active RFID asset tags, data rich high performance tags, sensor tags that monitor security and environmental conditions and related fixed and mobile readers. This is important for tracking container assets that many contain a lot of information about individual assets within the container. The tags can provide alerts to users if the containers have been tampered with, misdirected or experience extreme environmental conditions.
- The company's fully integrated site and enterprise software products provide customers a complete solution for tracking shipments worldwide.

Savi has a majority interest in Savi Networks, LLC, which is building a public network infrastructure of active RFID network assets at major ports around the world. Customers who outfit their containers with Savi's asset tags will be able to automatically receive data on their desktops about the location and contents of their in-transit asset shipments. The data can be automatically loaded into customer supply chain applications.

The acquisition enables Lockheed Martin to meet growing requirements for "smart" logistics systems that ensure timely deliveries, enhance security and situational awareness, deliver cost savings, optimize inventory levels and improve operational performance and efficiencies.

The new organization will be a wholly owned subsidiary of the Corporation, known as Savi Technology, a Lockheed Martin Company.

> "The *tags* can provide ALERTS to *users* if the containers have been TAMPERED with, *misdirected* or experience *extreme* environmental CONDITIONS."

JASSM Cruise Missile Weapon Data Link Development

Lockheed Martin will develop a Weapon Data Link-WDL — capability that will enable the extended-range JASSM™ system to engage mobile and time-critical targets.

The JASSM air-to-surface standoff missile system is the world's first stealthy conventional cruise missile.

The WDL will provide the extended range JASSM missile with two-way, secure, beyond-line-of-sight-communications capability with the Combined Air Operations Center. The CAOC may send target location updates and changes to the missile while it is in flight, and the missile will report its position and status until impact.

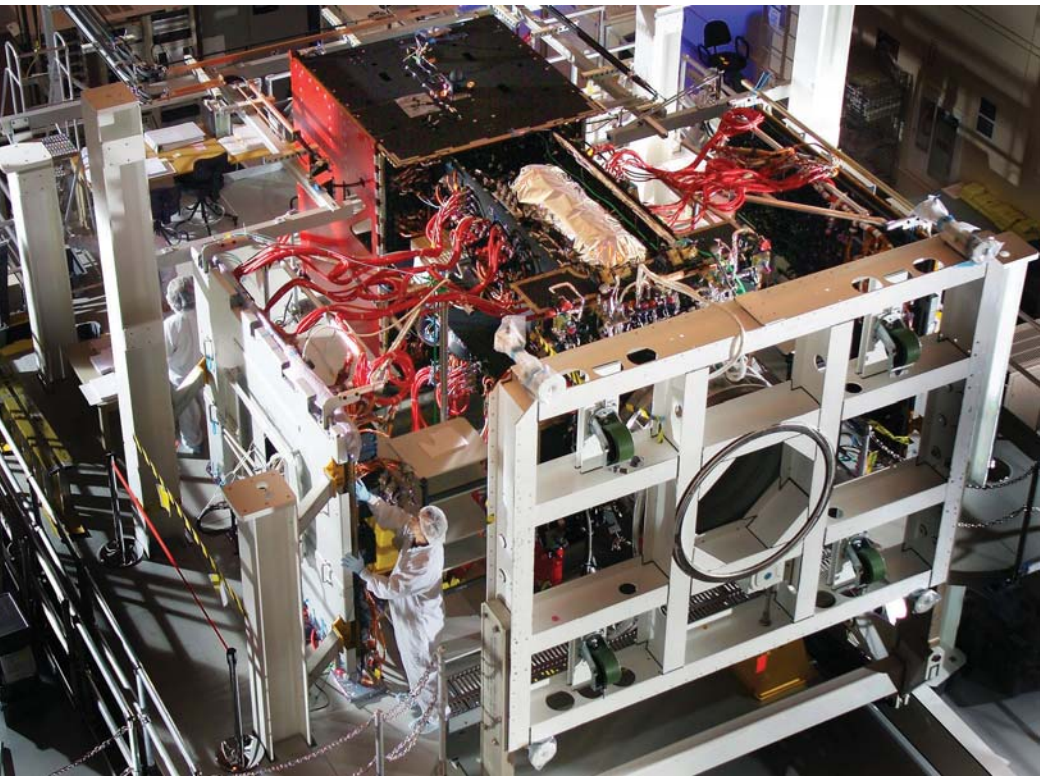
This communications link is a key enabler of a future maritime interdiction capability in the missile.

The WDL system will use the standardized data link architecture for network-enabled weapons that was developed by a joint service advanced concept technology demonstration program. Lockheed Martin was a key participant in the program whose primary purpose was to specify, design, implement and demonstrate standardized tactical weapons communications architecture.

The U.S. Air Force and Lockheed Martin successfully demonstrated the WDL capability during flight test demonstrations conducted late last year.

Continued on Page 32.

Key Software, Hardware Delivered for SBIRS Missile Warning System



The Space-Based Infrared System team led by Lockheed Martin has delivered a critical payload subsystem along with software integral to the program's first geosynchronous orbit satellite.

The software will help make it possible to control and test the spacecraft's Pointing and Control Assembly. The Assembly features Lockheed Martin's patented reaction-less gimbal system, which allows the satellite to rapidly and repeatedly scan an area of interest for infrared activity while not interfering with the satellite's ability to simultaneously stare at another area.

The completed payload is scheduled to be delivered to Lockheed Martin's facilities in Sunnyvale, Calif., in mid-2007 for final spacecraft assembly, integration and test in preparation for launch in fiscal year 2008.

Spacecraft Functional Testing Progressing

The team is also in the midst of an important spacecraft test phase at Lockheed Martin's facilities in Sunnyvale, Calif. Known as Spacecraft Functional Testing this major milestone will verify the functional requirements of the geosynchronous orbit, or GEO, spacecraft.

These include functions such as electrical power, command and data handling, guidance navigation and control, and will further assure that the structure is assembled to specification.

New Ground System Capability

In a related item, Lockheed Martin has also completed development of the Highly Elliptical Orbit, or HEO, Interim Operations software for SBIRS.

This is an important achievement in delivering ground system capability to operate new SBIRS HEO payloads and GEO satellites. The new capability will expedite the processing of missile warning and technical intelligence data.

Since 2001, the SBIRS ground segment has been providing the nation with missile detection, battlefield data, and technical intelligence from the consolidated Mission Control Station at Buckley Air Force Base, Colo. Air Force crews are providing support to warfighter and homeland defense initiatives, Operation Iraqi Freedom and the global war on terror.

SBIRS, with its highly sophisticated scanning and staring sensors, will provide the nation with significantly improved capabilities to detect and accurately characterize emerging missile threats. Along with missile warning, it will support other missions simultaneously, including missile defense, technical intelligence and battlespace characterization.

Lockheed Martin is currently under contract to provide two HEO payloads and two GEO satellites, as well as ground-based assets to receive and process the infrared data. The Lockheed Martin team has delivered both HEO payloads. The first GEO satellite launch is scheduled for fiscal year 2008.

F-22 Raptor Delivered to Second Operational Squadron

The 94th Fighter Squadron, famous for its historic "Hat in the Ring" insignia and legendary aviator Eddy Rickenbacker, has begun to receive F-22 Raptors from Lockheed Martin.

Two of the 5TH Generation stealthy, air dominance fighters have been assigned to the second operational squadron in the U.S. Air Force. They join F-22s flying today as part of the 1st Fighter Wing's 27th Fighter Squadron at Langley Air Force Base, Va.

The Air Force declared initial operational capability for the Raptor late last year, and it is already flying operational missions in support of homeland defense.

The 94th Fighter Squadron legacy of being a frontline fighter unit spans from World War I to operations in the Persian Gulf Region. This unit has been a key player in the fight to gain and maintain air superiority.

In addition to the active air force, pilots with the 192nd Virginia Air National Guard in Richmond are also flying F-22 Raptors. The F-22 Raptor is currently flying at three other bases across the United States:

- Testing is conducted at Edwards Air Force Base, Calif.
- Tactics development is ongoing at Nellis Air Force Base, Nev.

> "This unit has been a key player in the fight to gain and maintain air superiority."

- A full squadron of Raptors is based at Tyndall Air Force Base, Fla., for pilot and maintainer training.

The F-22 dominates any adversary through unmatched performance achieved through stealth, supercruise speed, agility, precision and a complete view of the battlespace achieved with the advanced sensor suite embedded in the aircraft. The Raptor will enable combat commanders to change the way wars are fought over the next 40 years.

New Integrated Weapons System for A-10C Flight Test Program

Sniper and LITENING targeting pods have been integrated into a new weapons delivery system for the U.S. Air Force's A-10C flight-test program.

A team led by Lockheed Martin developed the new system, called Digital Stores Management System. It automates many of the weapons control functions that A-10 pilots today perform manually.

With either targeting pod, the system will vastly improve an A-10 pilot's ability to identify targets and provide laser guidance of precision air- to-ground weapons.

The Air Force has designated the Joint Direct Attack Munitions and the Wind Corrected Munitions Dispenser guidance kits for the A-10C aircraft. Each kit converts existing free-fall bombs into accurately guided "smart" weapons, allowing pilots to attack from higher altitudes and in adverse weather conditions.

The DSMS weapons capability is the latest in a series of upgrades delivered by the Lockheed Martin Prime Team for the A-10 Precision Engagement program.

IPv6 Transition Support Offered

Lockheed Martin has created an Internet Protocol version 6 — IPv6 — Transition Support Office to assist customers in IPv6 implementation, migration and implementation.

The Transition Support Office will leverage advanced research and development in its two labs, offering support to all Lockheed Martin lines of business with IPv6-related requirements.

The Corporation has touted the IPv6 office as a corporate Center of Excellence and is investing in research and development to help shape the future of communications network architecture development.

The Office of Management and Budget has mandated that the federal government upgrade from Internet Protocol version 4 to IPv6, the next-generation internet protocol. IPv6-enables global, net-centric operations, which translate an information advantage into a decisive advantage for the warfighter.

Advanced Surveillance System for Submarines

An advanced digital imaging and processing technology is revolutionizing surveillance capabilities for U.S. Navy submarines.

ISIS — the Integrated Submarine Imaging System — was developed by Lockheed Martin in collaboration with Kollmorgen Electro Optical. Lockheed Martin engineers designed the ISIS inboard computer processing system and displays for the Navy's submarine force.

Here is how it works:

- The ISIS system replaces the optical light path of existing submarine periscopes with an advanced system that integrates new periscope-mounted high-resolution cameras and fiber optic digital imagery while allowing images to continue to be viewed via the optical path. A conning officer would manipulate an outboard camera with a joystick while observing the digital video on a computer monitor;
- An onboard suite of video processing equipment allows the real time display and analysis of video images on existing submarine control room tactical displays. The image can be shared with the combat team on various displays aboard the sub;
- The ISIS system provides submarine operators with image enhancement capabilities and analysis tools for both real time and recorded imagery; supplied active and passive range finding control; and recording, storage and recall capabilities for imagery and associated data;

- Infrared cameras provide enhancements to the images which can be transmitted off the submarine to other naval and joint forces.

The system is being installed aboard the USS Hampton, making it the first U.S. Navy submarine to receive the system. ISIS will eventually become the Virginia-class submarine image processing system.

"The need to have the submarine commander or conning officer handle a traditional periscope will become part of naval history as ISIS is installed in the U.S. Navy's submarine force," says Eric Gruenloh, Lockheed Martin's ISIS program manager.

Entire THAAD Weapon System Tested

All elements of the Terminal High Altitude Area Defense weapon system were successfully tested at the White Sands Missile Range recently. The test proved the system's capability.

The test demonstrated all major elements of the THAAD weapon system as it engaged a virtual target. These included the interceptor launch and control; kill vehicle control in response to in-flight uplinks; seeker operation; and radar acquisition, track and in-flight communications with the interceptor.

This marked the second successful THAAD developmental flight test since flight testing resumed for the program late last year. Three more test flights are scheduled to occur at the White Sands Missile Range in New Mexico before THAAD testing moves to the Pacific Missile Range Facility in Hawaii.

The THAAD weapon system is designed to defend U.S. troops, allied forces, population centers and critical infrastructure against short- to medium-range ballistic missiles. It uses hit-to-kill technology to destroy targets, and is the only weapon system that engages threat ballistic missiles at both endo- and exo-atmospheric altitudes.

JASSM Cruise Missile Weapon Data Link

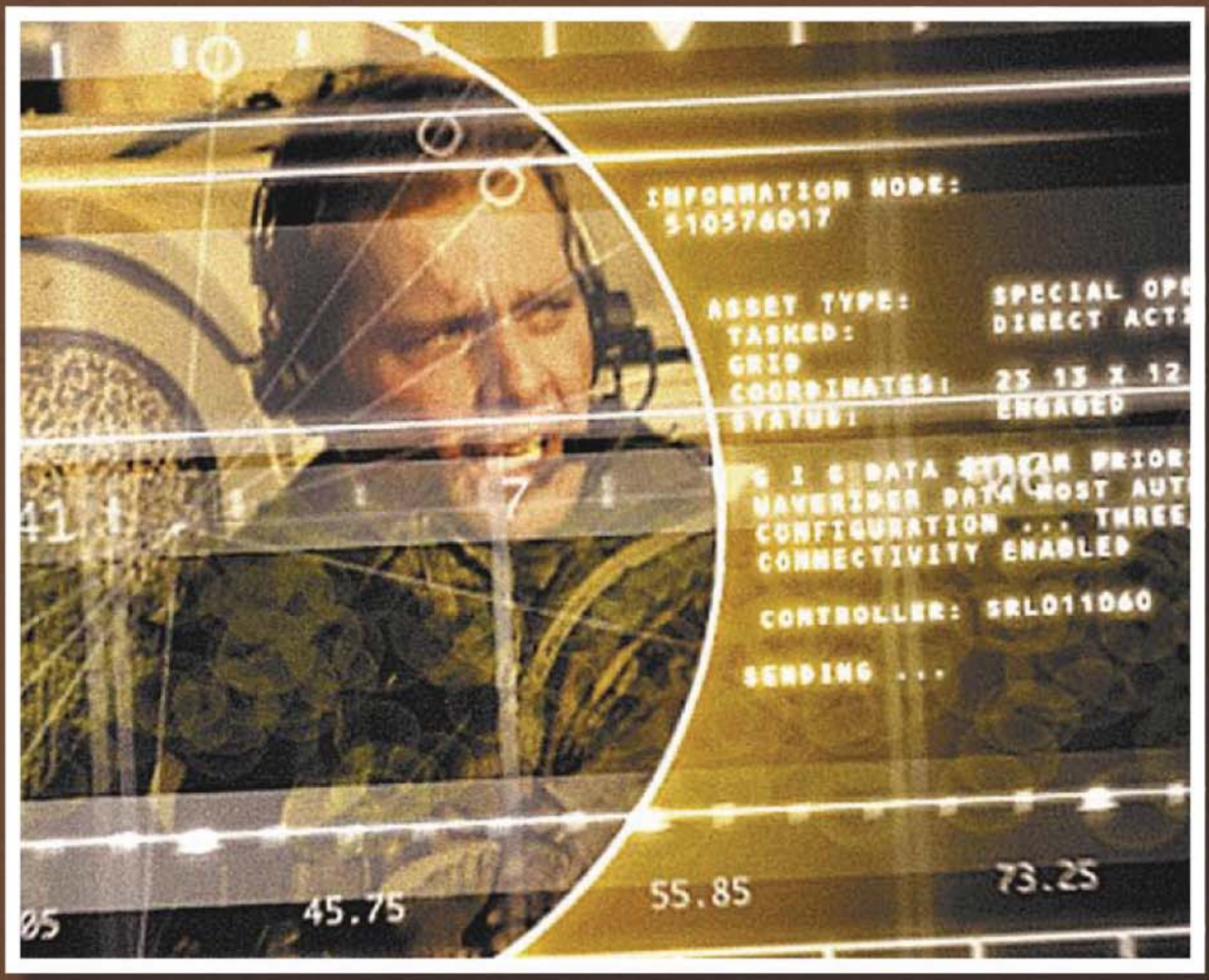
Continued from Page 29.

First Development Flight Test

The first development flight test was successfully performed at the White Sands Missile Range in New Mexico recently.

The test is the first all-up-round flight test to verify modifications that are specific to the extended range missile configuration. This flight will be followed by a series of integrated U.S. Air Force and Lockheed Martin development and evaluation test flights to prove out the JASSM-ER missile configuration on the B-1B aircraft platform. Each flight will be an end-to-end test, with successive tests providing an increasing evaluation of the total JASSM-ER system.

"This missile provides JASSM's proven lethality and accuracy with extended range to give the B-1B warfighter an outstanding operational capability for first-day strike of heavily defended targets," said Air Force Lt. Col. Stephen Davis, 677th Armament System Squadron Commander at Eglin Air Force Base, FL.



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