

# SAIC Magazine

Winter 2001

*Innovative Solutions for safety and security*



**SAIC VACIS**

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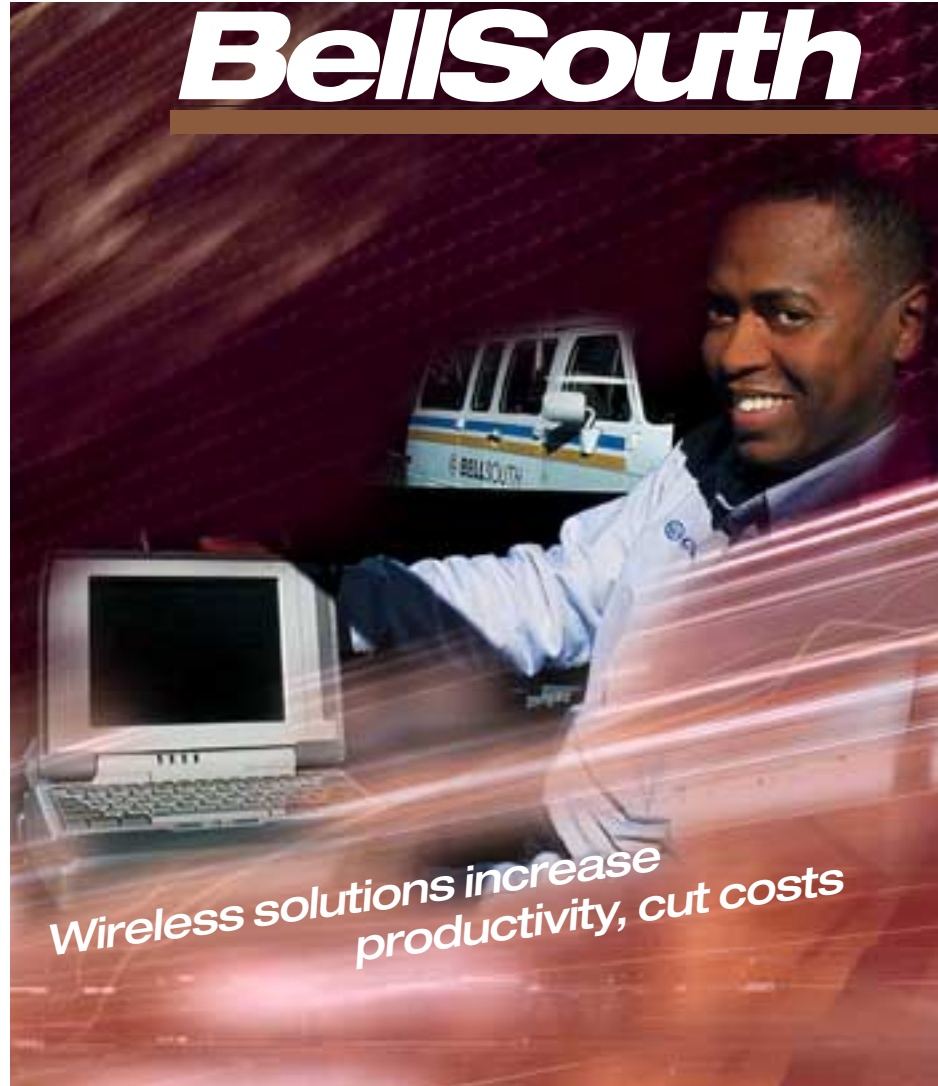
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***“When BellSouth made the decision to adopt a new technology that had the ability to enhance customer services, provide technicians with safety features, and provide a solution for our current dispatch system, SAIC responded to those needs,” states Rick Hamrick, GPS Manager at BellSouth. “The value gained from this system has encouraged BellSouth to consider expanding this product into the remainder of its fleet.”***

## ***calls on GPS tracking system for faster, better customer service***

**H**igh customer satisfaction ratings and low operating costs. No industry wants to accomplish both goals more than telecommunications – a highly competitive industry undergoing major changes.

BellSouth, a leading international telecommunications company with one of the most modern telecommunications networks in the world, has a fleet of 15,000 installation and maintenance vehicles. Fast, efficient response of the mobile workforce has a direct influence on customer satisfaction, annual operating costs, and bottom-line profits. BellSouth's decision to actively and in real-time manage this critical resource led to one of the largest fleet and workforce management systems in the United States. The system, which has helped to dramatically raise productivity and lower costs, was developed and implemented by SAIC.

### **The FleetOptimizer solution**

BellSouth wanted a system to monitor fleet operations and workforce efficiency and quickly evaluate trends, operational processes, and performance issues, even in remote deployments. In addition to monitoring operations, the system would have to interface with dispatch and corporate systems, and be accessible to supervisors in all locations. SAIC and its Telcordia Technologies subsidiary had the right expertise to successfully implement this project: SAIC's GPS tracking, wireless communications, Web-enabled software development and integration expertise was combined with Telcordia's Force dispatch application, currently running at BellSouth.

To meet BellSouth's needs, SAIC customized its FleetOptimizer system. FleetOptimizer is designed to track and manage large, geographically dispersed

vehicles or fleets. It is flexible enough to interface with various applications and communicate over multiple wireless systems. The 15,000-vehicle fleet, spread over a nine-state region, is tracked by GPS satellite and reports back to BellSouth data centers. Supervisors access data through a Web interface.

### **Sizable fuel savings**

Telcordia and SAIC linked FleetOptimizer to another key system – Telcordia™ Force, a computer-aided dispatch application that manages service to BellSouth's customers. The Force system assists scheduling, assignment, routing, and helps dispatch technicians qualified to solve specific problems.

Integration with Force reduced overtime, multiple dispatches, drive time, radio talk time, and “no access” attempts to deliver service. The result: reduced mileage for BellSouth's fleet and significant fuel savings, far surpassing the original goals.

### **Productivity goals exceeded**

The FleetOptimizer system now makes real-time information available on each vehicle in the fleet, including information on the truck, driver, job site, driving speed, and job route. Managers can see a visual display of a moving vehicle or access route history information to determine performance.

Productivity gains from the system have been significant. BellSouth was expecting a 4% productivity enhancement from its new workforce management system. Far exceeding expectations, the system has significantly increased productivity. The increase in productivity will allow the system to pay for itself in about 30 months.

In addition to boosting performance, the system makes the technician's job safer. Alert call buttons



*Making a difference*  
**IN THE FIGHT**  
A G A I N S T  
*Cancer, AIDS*



Picture the September 11 terror strikes multiplied 100 times. That would equal more than half a million dead, about the same number of people who die every year from cancer.

To help fight cancer, AIDS, and related diseases, the National Cancer Institute (NCI) asked SAIC to continue its leading-edge research for NCI's Frederick Cancer Research and Development Center. Our SAIC-Frederick subsidiary manages and operates the center, which screens compounds for anticancer and antiviral properties, conducts basic and applied research in cancer and AIDS, and operates a high-performance computer devoted strictly to biomedical research.

The \$1.8-billion, seven-year follow-on contract includes more than 1,400 SAIC scientists, technicians, and support staff. According to Dr. Larry Arthur, who directs the center (and directs its AIDS vaccine program), SAIC is highly valued by the center's employees.

SAIC's scientific commitment and employee ownership culture have been key factors in the success of the contract, which we first won in 1995, says Dr. Arthur. We were founded and are managed by scientists who understand research and the research process, and this makes SAIC an excellent "fit" at NCI-Frederick.

Dr. Arthur notes that SAIC's employee owners are very proud of the work they perform at the center, located at the Fort Detrick Army base in Frederick, Maryland.

"You don't want to sound too trite but we are helping fight cancer and AIDS," says Dr. Arthur. "No matter what aspect of work they are asked to do, our employees know that they are assisting in these research efforts. In fact, sometimes it really hits them that they are making a difference, especially when a relative or friend gets cancer or AIDS."

In the near future, SAIC-Frederick will construct and operate a vaccine development facility (to be located on the Frederick campus) for the Dale and Betty Bumpers Vaccine Research Clinic. Dr. Arthur says he has already hired a director for the facility, which will produce AIDS vaccines for human testing.

"I think this is a very important contract for the company," says SAIC Executive Vice President Steve Rockwood. "It gives us participation and insight into an important new area of biotechnology. I think biology will be a key science for the next decade or more and having SAIC participate through this contract is an excellent way for us to serve the country and be part of very important activities." ■



**The Frederick campus has a distinguished history of performing on the frontier of medical science. For example, Dr. Larry Arthur's lab was the first U.S. lab to receive and produce HIV-infected cells (prior to SAIC's first management and operation contract with Frederick), to be used by various companies to develop HIV tests of blood transfusions. At that time, about 5,000 people per year became infected from the HIV-tainted blood transfusions. Now, thanks to implementation of these testing procedures, less than 40 people a year die from transfusions.**

**In fact, the overall AIDS death rate in the U.S. has fallen significantly due to the efficiency of compounds, antivirals, used to "kill" HIV (which reduces the amount of virus circulating in an HIV-infected person). Basic research, such as the type done at SAIC-Frederick, has contributed to the development of the antivirals. In addition, Dr. Arthur and his SAIC staff have contributed in other areas of AIDS research. For example, Dr. Arthur co-authored an article in *Nature* magazine (February 1999) that confirmed that HIV came from chimpanzees.**

**While SAIC is helping contribute to AIDS treatments, Dr. Arthur says that he believes science is on the verge of major discoveries for cancer treatments. This is due to the sequencing of the human genome and the ability this gives us to look at how cells become cancerous.**

**"By looking at various proteins that cancer cells produce, we can understand the pathways of why cells become cancerous and then we can make designer drugs to kill those cells," says Arthur. "I expect to see major developments in cancer detection and treatment in the next five to ten years."**

**In the meantime, SAIC-Frederick researchers continue their work fighting cancer. In the August**

# *Protecting the Borders*

From Kosovo to Mexico to ports of entry and border crossings throughout the United States, SAIC's Vehicle and Cargo Inspection System (VACIS) has been used to examine trucks, railcars, containers, cargo and passenger vehicle contents for drugs, explosives, weapons, and other contraband.

***Innovative solutions for safety and security***



## TEAMWORK PAYS OFF

According to a U.S. Customs news release, inspectors at a border checkpoint in Pharr, Texas, spotted something suspicious in a refrigerated tractor-trailer loaded with papayas. The inspectors ordered the vehicle to a nearby location for a VACIS gamma ray scan, which showed irregularities in the trailer's floor beam area. Sweete, a drug-sniffing Customs canine, searched the trailer and alerted inspectors to a portion of the floor. They extracted 291 bundles containing 1,555 pounds of marijuana with an estimated street value of \$1.5 million.

## HOW IT WORKS

VACIS works by emitting a low-level beam of gamma radiation.

As the narrow vertical fan beam of low-level radiation penetrates the vehicle, the absorption of this radiation is progressively measured by the extremely sensitive array of detectors located on the opposite side. This absorption data is then fed to a computer, where a digital image is formed and optimized for display on a high-resolution video monitor.

The radiosopic image of the object can then be analyzed by the operator. Additional image analysis is available to the operator through a suite of software image-processing tools. Image storage, transfer and recall are possible.

The VACIS technology has received worldwide recognition for its efficacy and innovation. In 1998, SAIC's VACIS won an award in the Transportation category of the Computerworld/Smithsonian Awards Program.

With the heightened interest in counterterrorism, this non-intrusive gamma ray imaging system, which can reliably scan a 40-foot sealed container in less than 10 seconds, is expected to play an even greater role in helping the U.S. and its allies safeguard borders.

Over the last several years, the U.S. Customs Service has deployed a significant number of VACIS systems at various ports of entry. Recently, we won contracts from Malaysia and Canada to manufacture and deliver both our relocatable and truck-mounted mobile versions of VACIS. In addition, Mexico has purchased a railroad version of VACIS, which can scan railcars moving up to 10 miles per hour

as they pass through border entry points.

The truck-mounted system also is being used by U.S. National Guard units in New York and California, says SAIC Operations Manager Jim Winso, whose staff is conducting a long-term demonstration to Government officials in the Washington, D.C., area.

VACIS allows operators to view gamma-ray images on a video monitor to quickly and efficiently identify hidden compartments, contraband or human cargo, as well as help verify contents with manifests.

And, since it requires a very low radiation dose rate, VACIS can be operated without a special protective building or similar

enclosure. This increases the simplicity and decreases the system purchase price. The initial cost is significantly less, and annual maintenance costs are significantly less than comparable x-ray machines.

Although VACIS operates as a fixed system, it can easily be relocated and set up within two days. The truck-mounted system provides additional flexibility since it can be used without external electrical power or other infrastructure and can be set up in less than 15 minutes with a two-person crew.

Another version of the system can inspect air cargo containers at aviation facilities.

To learn more about VACIS products, visit [saic.com](http://saic.com). ■





IN ITS ANNUAL COMPETITION, SAIC'S EXECUTIVE SCIENCE & TECHNOLOGY COUNCIL RECOGNIZES SOME OF THE MOST INNOVATIVE RESEARCH AND BEST WRITTEN TECHNICAL PAPERS AND BOOKS BY SAIC SCIENTISTS AND ENGINEERS. THIS IS THE FIRST SUMMARY OF THE LATEST AWARD WINNERS.

# Iran and nuclear, biological, and chemical weapons



The U.S. Government contends that Iran has developed and used chemical weapons, has created biological agents for use as weapons, and seeks to build nuclear weapons. While to date Tehran has not been implicated in the September 11 terrorist attacks and the ongoing anthrax scare, Iran's weapons of mass destruction and support for terrorism will undoubtedly come under closer scrutiny by the U.S.

Because such weapons pose a great threat to U.S. military forces and political objectives in the region, it is vital for the U.S. to understand Iran's intentions and capabilities regarding nuclear, biological, and chemical weapons. In his award-winning paper, Gregory Giles provides this insight.

Several factors influence Iran's nuclear, biological, and chemical weapons policy. These include a history of volatile civil-military relations, Islamic militancy, lessons from the Iran-Iraq War, and lingering regional

insecurities.

According to Giles, there are tensions between Iranian civilian and military leaders over unconventional weapons doctrine. Iran's civilian (that is, religious) leaders mostly view nuclear, biological, and chemical weapons as a deterrent to regional enemies, such as Iraq's Saddam Hussein and Israel, and as a possible deterrent to a U.S. conventional attack. In contrast, the Islamic Revolutionary Guard Corps (IRGC), which Iran's ruling mullahs created as a political counterweight to the regular army, has made preparations to use chemical – and possibly biological – weapons offensively against U.S. naval forces in the Persian Gulf.

Subordinating the IRGC's views to Iran's overall defense strategy is an urgent task for Iran's civilian leaders if they are to control when and how that country uses its unconventional weapons.

This may be difficult because the IRGC, as the official “defender of the

Islamic revolution,” controls Iran's nuclear, biological, and chemical programs, dominates Iran's naval forces, and controls Iran's long-range ballistic missiles. (In addition to the IRGC's relative autonomy, it has powerful protectors among radical clerics.)

Tied to this effort to protect the revolution (that is, reduce the prospect of a military coup) is the mullahs' encouragement of bureaucratic friction and competition by assigning nearly a dozen organizations overlapping responsibilities in chemical weapons production. This ensures continued bureaucratic competition for resources, missions, and influence. With so many entities involved in the chemical weapon complex, a “production push” mindset contributes to a proliferation of chemical weapons systems. In fact, Iran turns out chemical weapons munitions for every major type of delivery system, including mines, artillery, aircraft, and ships. (Giles focuses on chemical weapons capability as it is the most mature of Iran's



unconventional weapons programs.)

Giles notes that while Iran's military can deploy chemical weapons on the battlefield, at sea, and against distant strategic targets, the IRGC's exclusive control over long-range missiles and chemical weapons storage constrains the regular army's ability to integrate chemical weapons into its force structure.

To gain insight into Iranian philosophy on using unconventional weapons, Giles notes Iran's behavior in its 1980-1988 war with Iraq.

Iran was slow to respond to Iraq's introduction of chemical weapons into the conflict largely due to Islamic prohibitions on the use of poisons as weapons of war. Iran overcame this inhibition, however, and used chemical weapons mainly against Iraqi troop concentrations. In one instance, Iran used chemical weapons against the Iraqi village of Halabja. Iran's leadership was particularly concerned about possible Iraqi use of unconventional weapons against Tehran and other Iranian cities.

Because of the tremendous psychological effects of Iraq's chemical weapons attacks (which killed only 5,000 Iranians but contributed to Tehran's acceptance of a cease fire), the Iranian military has made a concerted effort to improve its ability to operate in a nuclear, biological, and chemical



environment. In fact, since the end of the U.S.-led Gulf War, Iranian unconventional exercises have increased greatly. This suggests that Iran's armed forces are looking to nuclear, biological, and chemical weapons to offset a U.S. advantage in high-technology conventional weapons.

One way to do this is using tactical chemical and biological weapons at sea – a method evidently favored by the IRGC, which operates its own naval forces. The IRGC favors this method because Western military officials tend to underrate this strategy and because U.S. and other naval forces in the Persian Gulf are not equipped with chemical and biological weapons to act as a deterrent.

Having pitted the IRGC against the regular military, Iran faces a struggle to get them to act in a coordinated way.

In fact, central command and control over unconventional weapons may not be assured given the production and organizational obstacles that these bodies present. The result could be a system where Iran has distinct rules of engagement and control mechanisms for each type of unconventional weapon. For example, the IRGC could have tight control over chemical weapons, but Iran's mullahs could turn to other organizations to control biological weapons (deemed more dangerous than chemical weapons), and, in the future, nuclear

weapons to counter-balance the influence of the IRGC.

How these factors might shape Iranian thinking about weapons of mass destruction after the September 11 attacks remains to be seen, says Giles. Such weapons may well take on greater importance as a means of deterring the U.S. from eventually carrying the war against terrorism to Iran. Iranian misgivings about U.S. intentions in this regard suggest that future confrontations with Iran will need to be carefully managed to avoid possible escalation to the use of these weapons.

Giles's award-winning paper, "The Islamic Republic of Iran and Nuclear, Biological, and Chemical Weapons," appeared as a book chapter in *Planning the Unthinkable: How New Powers Will Use Nuclear, Biological, and Chemical Weapons*. ■

# TRACKING KILLER CLOUDS

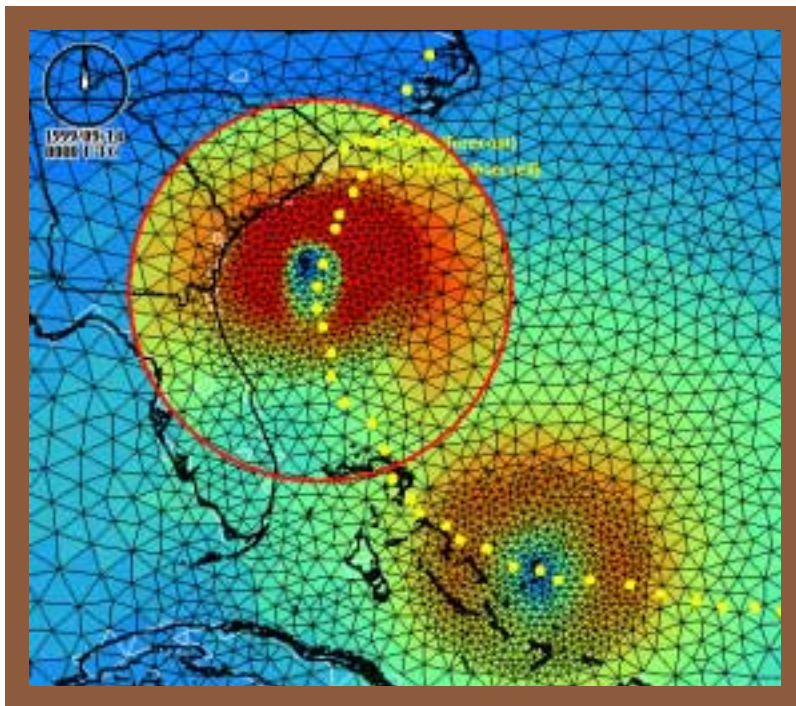


A huge explosion near your city sends a

plume of smoke high in the atmosphere. The smoke could contain hazardous chemicals or even nuclear radiation. To help plan evacuations and save lives you need to predict where ambient winds will take the smoke.

Making precise predictions is difficult due to the effects of rugged terrain, bodies of water, and other surface properties; but the SAIC Center for Atmospheric Physics can make very accurate real-time dispersion and weather predictions through OMEGA, a high-resolution atmospheric simulation and modeling tool.

By melding new computational “gridding” technologies from the fluid dynamics realm with numerical weather prediction techniques, OMEGA provides very high resolutions to model and simulate hazardous releases and other atmospheric conditions in a computationally efficient manner. In fact, OMEGA’s technology (an atmospheric dispersion algorithm combined with an unstructured computational grid that adapts quickly to surface features) resolves surface features down to one kilometer where



needed (e.g., in urban areas, air route corridors, and hazardous release locations). In regions with complex terrain and land and water boundaries – the main factors that affect surface winds – OMEGA automatically provides increased grid resolution, improving the solution. Additionally, OMEGA adapts its unstructured grid to dynamic features in weather, such as fronts, squall lines, and hurricanes.

On top of predicting the flow of hazardous chemicals or hurricanes, OMEGA (which stands for Operational Multiscale Environment Model with Grid Adaptivity) can accurately predict the temperature in a given area up to 72 hours in the future. This has great commercial

promise, especially for the power industry, which could save money by better estimating future energy consumption.

Because you can reconfigure OMEGA quickly, you can use the system practically anywhere in the world. In fact, OMEGA, developed with support of the Defense Threat Reduction Agency (DTRA), has been used in the past to support the National Command Authority (the U.S. focal point for continuous monitoring and coordination of worldwide

military operations.)

In addition, SAIC used OMEGA to reanalyze the weather conditions that occurred during Operation Desert Storm to help resolve issues surrounding the release of chemical agents at Khamisiyah, Iraq, during the war.

The article that Dr. David Bacon, the Director of the Center for Atmospheric Physics co-authored with SAIC’s Nash’at Ahmad, Zafer Boybeyi, Thomas Dunn, Mary Hall, Pius Lee, R. Ananthakrishna Sarma, and Mark Turner, “A Dynamically Adapting Weather and Dispersion Model: The Operational Multiscale Environment Model with Grid Adaptivity (OMEGA),” appeared in *The Monthly Weather Review*. ■

# FAST

## Atmospheric Predictions



Since the September 11 terrorist attacks on the U.S., our Government has been running “what if” scenarios involving theoretical airborne releases of anthrax, smallpox, and other hazardous agents. The scenarios, for many U.S. locations, include model predictions of where the airborne hazardous agents could flow under various conditions.

The Defense Threat Reduction Agency stands confident about its predictions because DTRA previously used the same SAIC atmospheric models to calculate, in real-time, where an actual hazardous plume would head on the White Sands missile range in New Mexico.

For that test, DTRA researchers raced in trucks on the missile range using SAIC’s data and found the plume (sulfur hexafluoride). SAIC followed up by comparing the model calculations and subsequent plume tracking data. In their ESTC award-winning paper, Robert Cox, John Sontowski, and Catherine Dougherty verified that DTRA could use models that coupled wind predictions with an atmospheric and diffusion system to quickly and accurately predict the path of hazardous dispersions.

For the study, our researchers constructed high-resolution wind fields over complex terrain in minutes by feeding meteorological data into MINERVE, a mass consistency wind field model. The raw data – fed into MINERVE – that produced the best results came from a mobile profiling system, a radar wind system that takes readings in the troposphere. (A separate modeling used data from weather balloons.)

Our researchers then put the MINERVE calculations into an atmospheric transport and diffusion model, called SCIPUFF. The SCIPUFF model generated a prediction of where the plume would travel. Then we compared SCIPUFF’s prediction of the plume’s location to (plume) tracking data using a highly reliable spectral analysis technique (Fourier-transform infrared spectroscopy).

The SCIPUFF prediction of where the plume traveled ended up more than 90% accurate. (The prediction was less accurate when using raw data from weather balloons.) The benefit of using this modeling system is that you can accurately predict within minutes how a plume of hazardous agents will move.

The ESTC Award-winning paper, “Comparison of Atmospheric Transport Calculations over Complex Terrain Using a Mobile Profiling System and Rawinsondes,” appeared in *Meteorological Applications*. ■

## Monitoring for nuclear test-ban violations



Is it technically feasible to verify compliance with the Comprehensive Test Ban Treaty? To find out, scientists have conducted a series of tests to develop an experimental seismic monitoring system. The scientists were members of an international consulting body to the United Nations Conference on Disarmament.

In an ESTC award-winning paper, SAIC’s Jan Wuester and colleagues evaluated the results of the Group of Scientific Experts third Technical Test (GSETT-3). The objective of this latest test: develop the seismic component intended to evolve into the future International Monitoring System (IMS). The IMS is a global network of diverse sensors that must be able to accurately detect and locate a seismic event, such as an earthquake, anywhere in the world and provide information to facilitate the determination if it is, in fact, a nuclear detonation.

The study identified areas where upgrades are required to assure the experimental seismic monitoring system will perform as expected, and that it can evolve and adapt to support future requirements.

Among the observations: The detection capability of the experimental monitoring system came close to projections, but the ability to locate events was somewhat less satisfactory; and the ability to determine event depth was unsatisfactory for two-thirds of all events.

While there will be some improvement in capabilities as more stations come on line, new computational methods and better regional calibration will be needed to improve the depth determination of the monitoring system, the authors concluded.

Their article, “GSETT-3: Evaluation of the Detection and Location Capabilities of an Experimental Global Seismic Monitoring System,” appeared in the *Bulletin of the Seismological Society of America*. ■



# The Art of Objects



Have you ever e-mailed a co-worker and then

wanted to send another similar e-mail to someone else? Probably you edited the original message and sent that one instead of creating a whole new message.

This reuse philosophy stands as the basis of object-oriented programming, where you create stand-alone “objects” that you can later modify for other programs. For example, you could create an object code to display a window onscreen that anybody could copy and modify.

In addition, programmers can move objects in chunks to create whole new programs. This flexibility allows programmers to become significantly more efficient and productive.

In his ESTC award-winning book, *The Art of Objects*, SAIC’s Yun-Tung Lau provides the fundamentals of object technology [using the unified modeling language (UML) as the primary means of presentation] along with many contemporary and advanced topics. The book will give you a greater understanding of object design patterns and the ability to use them to solve many design challenges. This includes real-life case studies that demonstrate how to put the static and dynamic object design patterns to work. For example, the book describes how to build system software for an automatic teller machine (ATM). This includes a (static) requirement to keep records of all ATM transactions and uses and a (dynamic) requirement to handle access to the same account.

Beyond the design level, the book covers important topics in object architecture. These include object creation and destruction, associations and links, and aggregation and inheritance.

According to one reader, “The book covers the basic concepts of object classes, associations, etc., in a very understandable manner... the book also contains needed chapters with intermediate and advanced topics, which is seldom found in other object-oriented books.”

Another reader noted, “[The book] certainly gives you all the essence of object programming. With it you can probably design better Java codes or even C++ codes in the future.” ■



In the future, high-power microwave weapons could replace conventional weapons in disabling enemy air defenses, disrupting enemy communications, and protecting against anti-ship missiles. But important research is required before this type of directed-energy weapon can reach its potential.

SAIC physicist Alexander Vlasov and a team of scientists from the University of Maryland are helping develop a new generation of HPM devices that are smaller, lighter, and more powerful. In a major achievement, they were able to create the first portable HPM generator. They did so

## Microwave

by creating a device that uses less voltage, which allowed its weight and size to be substantially reduced. Their new device, a large-diameter, surface-wave microwave oscillator, can generate significant amounts (gigawatt levels) of the most powerful microwave radiation (small wavelength radiation in the millimeter-centimeter range) at significantly lower levels of power supply (at or near 500 kilovolts).

To create this new device, Vlasov and the other scientists had to overcome three major challenges. The vacuum HPM device they worked on creates microwave energy by injecting an electron beam into an electromagnetically charged vacuum. The team first had to find a stable electron beam that could sustain high current without causing unwanted microwave discharges inside the device. (The high

# Harvesting Light



While high-speed optical fiber carries long-distance messages around the world, much of the wiring in metropolitan areas is still copper. A new type of laser holds great promise to help convert this “last-mile,” as the telecom industry calls it, to fiber. As small as a grain of sand, this new laser can transmit more than 10 billion bits a second; that’s 400,000 times faster than a standard dial-up Internet connect. Called a vertical cavity surface emitting laser or VCSEL (which rhymes with “pixel”), the new laser could offer many other advantages for both communications and optical storage if scientists like SAIC’s Spilios Riyopoulos can solve some key challenges.

“Eliminating power oscillations and maintaining a single-mode laser under high power have been two of the holy grails of the communications business,” muses Riyopoulos. In his award-winning research, he introduces a novel method of overcoming these crucial performance barriers in VCSELs.

Dr. Riyopoulos’s discovery challenges the underlying physics of VCSELs. Unlike a traditional laser diode that emits light from its edges, a VCSEL emits light from its surface. Typically, as the light intensity increases, the density of electric charge carriers decreases and vice versa, which leads to power oscillations.

Riyopoulos hypothesized, “adding a photoactive layer within VCSELs would provide a coupling mechanism, enabling the VCSEL to control its own current.” The photoactive layer adds a varying resistance/conductance that changes with the intensity of light passing through it. Serendipitously, the added layer causes light intensity and carrier density increase or decrease in unison, discouraging spurious oscillations.

The photoactive layer also overcomes the second problem: maintaining a single-mode laser under high power, which is necessary for long-distance communications and optical storage applications. Under high power, the cross section of a laser typically changes so that it no longer matches the radiation profile of the optical fiber. A simple, single-mode laser (one that has a round cable shape with a bright center that fades radially) couples most effectively to fiber. The addition of the photoactive layer induces more conductivity at the center of the laser, encouraging single-mode operation under high power. That approach remains important, even in view of recent high-power single-mode operations by Novalux NECSEL, because it aims at high power via high-power density rather than through an increase in the emitting surface area and cavity size.

Through theoretical analysis as well as a numerical demonstration, Riyopoulos has proven that the presence of photoactive layers in VCSELs can eliminate both power oscillations and multiple modes. This breakthrough may allow fiber optic communication of orders-of-magnitude higher bandwidth under direct modulation. “By improving the funda-

current was necessary to produce high power from low voltage.)

Second, the team designed a vacuum structure for slow microwaves, that is, waves slower than the speed of light. When an electron beam enters this slow-wave structure, different frequencies can be excited, especially within a structure of large diameter. The structure’s cavity must support a surface wave that is synchronous with the electron beam to produce coherent microwave radiation without spurious oscillations.

Once the scientists found the appropriate surface wave mode, they were able to enlarge the structure’s diameter and the radiated power with-

## Attacks

out disrupting the surface wave. In particular, they were able to avoid the surface disintegration that typically limits HPM devices. (Even with the larger slow-wave structure, the new generator is still much smaller and lighter than its predecessors.)

Third, to create the most efficient interaction between the electron beam and slow-wave structure, the team experimented with all known surface profiles for the slow-wave structure. They found that a surface structure of semicircles on top of rectangles was the most successful.

To easily fine-tune the structure, the scientists found that small adjustments of an internal reflector (separating the electron gun from the cavity) dramatically changed the electrodynamic properties of the vacuum cavity.

Vlasov and his colleagues con-

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## Highly active antiretroviral therapy



By using a combination of drugs to directly attack HIV and reduce its levels in the blood, doctors have been able to effectively treat

people infected with the virus. But this highly active antiretroviral therapy, or HAART, is not a long-term solution for most patients because it can be toxic, is difficult to adhere to, and is expensive.

Therefore, scientists are searching for ways to control HIV infection while reducing a patient's reliance on HAART. For example, one possibility is to complement HAART with Interleukin-2, an immune system protein that stimulates production of CD4+ T cells.

Research has found that HIV destroys CD4+ T cells, which are crucial to the normal function of the human immune system, and that initiating HAART causes T cell counts to rebound. But there has been considerable debate on the topic of T cell turnover in patients infected with HIV. For instance, do the cell counts rise because HAART reduces destruction of existing T cells or because it enhances production of new cells?

An ESTC award-winning paper, published in the *Proceedings of the National Academy of Sciences*, sheds some light on this question. SAIC researchers with the National Cancer Institute's Frederick Cancer Research and Development Center and their teammates reported the results of a study on the "Impact of HIV-1 infection and highly active antiretroviral therapy on the

kinetics of CD4+ and CD8+ T cell turnover in HIV-infected patients."

The study provided a cross-sectional comparison of patients with HIV-1 infection with a healthy control group, along with a longitudinal study of patients initiating or voluntarily terminating HAART. The findings strongly support the hypothesis that CD4+ and CD8+ T cell division rates increase with the onset of HIV-1 infection and decrease after therapy. (In general, the role of the CD8+ T cells is to monitor all of the cells of the body, ready to find and destroy infected cells.)

The study concludes "there is an increase in the fraction of dividing CD4+ and CD8+ T cells in patients with HIV-1 infection and that this is the direct result of global immune activation caused by HIV-1 replication in the host. The fact that CD4+ T cell counts decline during the course of HIV infection suggests that the increased destruction of CD4+ T cells in the setting of HIV-1 infection is greater than this increased production."

According to the authors, therapies that shift the cell division rate above that of the cell death rate – such as Interleukin-2 – or decrease the cell death rate below that of the cell production rate – such as HAART – should lead to an increase in the size of the CD4 pool in patients with HIV infection.

The SAIC researchers who conducted the study are Richard Lempicki, Michael Baseler, Joseph Adelsberger, Robin Dewar, Ven Natarajan, Marjorie Bosche, Randy Stevens, and Laurie Lambert. ■

## Harvesting light

CONTINUED FROM PAGE 13

mental operation of VCSELs, photoactive layers will impact the entire communications industry," asserts Riyopoulos.

With a patent pending and feasibility studies and a prototype soon to follow, the future looks bright for the new technology. This research, "Elimination of Cavity Relaxation Oscillation in Vertical-Cavity Surface-Emitting Lasers with Photoactive Feedback," was funded in part by the National Institute of Standards and Technology (NIST) and appeared in the *Journal of the Optical Society of America*. ■

## Microwave Attacks

CONTINUED FROM PAGE 13

firmed their new design numerically and experimentally. In the experiments, the highest radiated power (0.5 gigawatt) was obtained from a relatively low beam voltage (570 kV) and higher current (5.8 kA) with a conversion efficiency of 15%, proving that a moderate voltage can indeed drive gigawatt-level radiation sources.

The study, "Overmoded GW-Class Surface-Wave Microwave Oscillator," which appeared in *IEEE Transactions on Plasma Science*, was sponsored by the Air Force Office of Scientific Research and the Office of Naval Research. ■

## Wireless

CONTINUED FROM PAGE 3

mounted in the vehicles and carried by technicians can send an emergency signal with information on the technician's location.

"SAIC's wireless solutions enable companies to increase productivity and effectiveness while reducing operational costs," says Dana Poirier, corporate vice president of SAIC's Wireless Systems Group. "SAIC works very closely with our clients to fully identify requirements and develop solutions optimized for their business environment. This results in quicker return on investment and higher levels of satisfaction with our solutions."

## Frederick campus

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15, 2001 issue of *Cancer Research*, our scientists reported that they developed new transplantable mouse tumor cell lines that produce slow-growing renal cell carcinomas. According to the article, these tumors share several traits with the human disease, offering a unique window into the biology of this poorly understood disease.

In addition to helping fight cancer and AIDS, SAIC-Frederick is helping fight terrorism. According to Dr. Arthur, under direction from NCI, we produced a prototype anthrax vaccine (for the U.S. Army Medical Research Institute for Infectious Diseases) that we have just released to undergo Phase I and II testing in people. It is hoped that this may be a vaccine that will prevent disease caused by infection by anthrax spores. ■



## Online service CONTINUED FROM BACK COVER

When a pilot recently reported a sudden change in turbine temperature on an engine, DS&S staff were called. Within minutes, a DS&S engineer was able to identify the problem. The faulty part was quickly identified and changed, avoiding the long delay that would have resulted if the airline engineers had not had access to the knowledge base developed through monitoring engines across the Rolls-Royce fleet.

This type of service, called Engine Health Monitoring, can save hours of troubleshooting time, preventing delays and cancellations, and keeping aircraft in service. DS&S Engine Health Monitoring services – currently serving 50 airlines operating nearly 2,000 Rolls-Royce engines – are available anywhere there is Internet access to [enginedatacenter.com](http://enginedatacenter.com).

### A welcome departure

The portal also makes easily accessible, for the first time, up-to-date engine performance data. Using sophisticated engine-trending software, DS&S staff can help identify potential problems as they are trending toward safe limits, before those limits are exceeded (the “red-light” in the cockpit) causing operational disruption.

For power plant engineers responsible for “everything below the wing,” this knowledge streamlines the entire monitoring and maintenance process.

- ▶ The secure portal gives fast notification of alert conditions – engines requiring urgent and potential attention – usually pinpointing the exact location of deterioration and its cause.
- ▶ The system tracks whether engines are running efficiently as well as the maximum ambient temperature in which each engine will operate.

Says Klaus Reymer, General Manager Engineering for Condor Flugdienst, Germany’s largest tour airline, “Enginedatacenter.com gives Condor real advantages because it

allows us to access engine health reports and get help with diagnosis and troubleshooting via the web.”

### How it works

The process begins with electronic sensors that measure more than 32 variables, including oil temperature and pressure, fuel flow, and shaft vibration. To determine the exact location of a problem, data is gathered at each of the three stages that compress air from low to intermediate to high pressure. A snapshot of data is gathered during the takeoff, climb, and cruise portions of each flight, as well as anytime a manufacturer’s limit is exceeded.

This data is immediately sent by radio or satellite to Data Systems & Solutions, where it is processed by engine-trending software, analyzed by DS&S staff, and made available on [enginedatacenter.com](http://enginedatacenter.com), usually in less than 10 minutes. Additional information from flight logs and maintenance records is used to track the life of critical parts.

The ability to closely monitor engine performance is critical to worldwide airlines, which operate out of cities that vary in altitude, ambient temperature, and runway conditions.

With detailed engine efficiency information, engineers can match routes and payloads to the right aircraft.

In addition, [enginedatacenter.com](http://enginedatacenter.com) tracks engine thrust, as the higher the thrust usage, the faster the engine will deteriorate. In this way, the Web site helps engineers extend engine life and meet warranty stipulations.

### The bottom line

With [enginedatacenter.com](http://enginedatacenter.com), power plant engineers can now accurately predict engine service needs. This capability reduces passenger flight delays, potentially improves safety, and saves airlines millions of dollars annually in maintenance costs.

For example, when engine damage is spotted early on, an engine can be repaired on-site or flown to a maintenance hub for repair or replacement. If maintenance problems cause a flight cancellation, the airline can incur up to \$50,000 in costs. Even more serious, if a new engine has to be flown to an inoperable plane, the cost can climb to \$500,000!

By helping reduce aircraft downtime, [enginedatacenter.com](http://enginedatacenter.com) has already helped generate dramatic cost savings. ■

## Aeromanager.com

Looking to lease an aircraft engine online? Check out [aeromanager.com](http://aeromanager.com), the Rolls-Royce e-business portal that provides a comprehensive range of services. This includes engine leasing and repair logistics service, interactive technical data, engine health monitoring, as well as information on repair and overhaul slots enabling airlines to go on-line to check their engines’ progress through the workshop. Data Systems & Solutions designed this ground-breaking web site with Rolls-Royce and an SAIC subsidiary, ANXeBusiness Corp.

# *Online Service* KEEPS AIRCRAFT *Flying*



**Internet portal  
enables airlines  
to monitor  
engines round  
the clock in near  
real time**

The next time you are flying at 30,000 feet, it may comfort you to know that a team of engineers is only a mouse click away should questions arise about the performance of your craft's engine. This feat is made possible by Data Systems & Solutions, a joint venture between Rolls-Royce and SAIC.

Data Systems & Solutions (DS&S) created a groundbreaking Internet portal for the aviation industry – [enginedatacenter.com](http://enginedatacenter.com). The portal gives airlines access to a wide range of products and services, including online repair and overhaul information, and predictions of engine service needs.

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