DARPA SBIR/STTR SUCCESS STORIES

2010

ADVANCING STATE-OF-THE-ART DEFENSE TECHNOLOGY

DARPA

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I am pleased to share the following success reports that illustrate how small businesses across the United States—through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs—have worked to support the Defense Advanced Research Projects Agency (DARPA).

DARPA challenges existing perspectives by taking what was once thought to be impossible, then improbable, and making it inevitable. This progression makes DARPA, and it speaks to the agency's mission of creating and preventing technological surprise for our nation's defense.

The agency's rich history of innovation led to the development of entire new industries and sources of economic growth in the United States. Small businesses have played a significant role in characterizing and solving complex problems related to defending our nation and generating ideas for cutting-edge technologies.

Fostering innovation and entrepreneurship goes hand-in-hand with innovative approaches to awarding contracts to small businesses. DARPA recently initiated a pilot program using Other Transaction Agreements to facilitate faster and more efficient options for awarding contracts to nontraditional small businesses. To date, the contracts processed using this mechanism were awarded in less than 30 days, compared to the traditional cost reimbursable mechanism that typically takes six months to one year.

The companies featured in this publication have developed technologies, products, and solutions that successfully address specific end-user needs while meeting many different challenges across a wide variety of disciplines. I congratulate these small businesses on their successes and look forward to their future contributions in solving important problems for the United States.

Dr. Kaigham J. Gabriel
Deputy Director, DARPA

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I am proud to present this publication featuring the transition success stories of 12 small businesses funded through the Defense Advanced Research Projects Agency (DARPA) Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. I share these stories to increase your awareness of the breadth of our country's intellectual capital that is working to solve important problems across a wide variety of industries, including national defense, healthcare, information technology, communications, manufacturing, and energy.

I hope these stories encourage small businesses and their industry and academic partners to explore the opportunities available through the SBIR and STTR programs to fund new ideas. The stories provide valuable insights into how innovation progresses—from an idea, to the lab for proof-of-concept demonstration, through development and testing, and to the field—and can be used in operational environments or commercialized into the private sector.

You may notice that several companies received funding more than 10 years ago. That's intentional. During the development of these stories, I specifically wanted to highlight the key factors that made a difference for these companies over the long term, and the subsequent advancement of the technologies into products and product lines.

I extend my sincere appreciation to all the companies showcased in this booklet for their cooperation and willingness to share their stories with others. I also thank the Foundation for Enterprise Development for creating this publication as part of its effort to inspire innovation and entrepreneurship aimed at solving problems of national and global importance.

Susan Nichols
Program Director, Small Business Programs Office
SBIR and STTR Program Manager

Technology Transition: Learning From Experience

DARPA's SBIR and STTR programs provide seed funding for small businesses to conduct advanced research required to prove the efficacy of innovative concepts and develop prototypes that can be benchmarked, tested and evaluated by potential integration partners and end users.

Successful transition and commercialization of technology requires a thoughtfully constructed transition plan aligned to the needs and requirements of military, federal and commercial markets, which can be a long and complex process. A company's business readiness, adaptability, access to financial and human capital, ability to collaborate with partners and end users, as well as perseverance and patience are essential elements needed to succeed.

Lessons shared in this publication provide insight for other small businesses currently involved in transitioning technology or on the verge of exploring an innovative idea with a DARPA program manager.

BUSINESS STRATEGY

- Target funding opportunities that map to the company strategy
- Identify potential military and/or commercial applications in proposal submissions
- Develop a hybrid business model to address both commercial and federal markets
- Balance a product's functionality and cost to meet market demand
- Anticipate and prepare for scaling up to sell and distribute products within appropriate markets
- Partner with larger defense contractors to secure access to channels for transition

TECHNOLOGY DEVELOPMENT

- Assess technology capabilities and user feedback during all stages
- Consider and evaluate alternative applications of a technology to expand transition opportunities
- Identify potential users early and enlist them to identify requirements and challenges
- Develop specialized tools to measure and assess the technology
- Partner with larger organizations to access technology and testing resources

THOUGHT LEADERSHIP/MARKETING

- Build awareness of the technology and your company by contributing to publications and presenting at technical conferences
- Create visibility for an idea or product at conferences, principal investigator meetings, and other gatherings of potential end users
- Select a memorable project name that conveys its use

INTELLECTUAL PROPERTY

- Obtain patents to maintain a dominant position in the market
- Protect intellectual property for licensing enabling technology to larger businesses that have production and marketing capabilities supporting transition into operational environments

DARPA seeks the most innovative ideas for creating and preventing technological surprise for our Nation's defense and looks forward to the future contributions of small business to inspire the development of new industries and sources of economic growth in the United States.

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ADAPX™
TURNING INK INTO ACTION

CONTACT INFORMATION

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Topic Name:	**Multimodal Command Interaction**
Topic Number:	**SB012-007**
Contract Number:	**DAAH01-03-C-R199**
DARPA Office:	**STO (formerly with IXO)**

ABOUT THE COMPANY

Adapx, Inc.
Founded 1999 -
CEO, Ken Schneider.
Adapx is a natural interface software company whose Capturx™ products improve field data collection, decision making, and collaboration. The company is transforming the way mobile teams collect and use data.

Products used by more than 500 organizations worldwide

VALUE PROPOSITION

Adapx's software and digital pens speed up field data collection and sharing by automatically digitizing handwritten text, symbols, and sketches on forms, maps, and other documents; incorporating voice; and integrating these into standard enterprise and federal applications.

Data is digitized when written on paper plans and forms for instant upload into leading commercial software

TECHNICAL CHALLENGE ADDRESSED

Military teams collect large amounts of field data on paper, and much of it is processed and shared through computer systems for better collaboration and faster decisions. However, the time gap between data collection and sharing can lead to slower, less informed decisions, because mobile computers do not fit the workflow and require excessive cognitive operations and training that distract from job performance. Also, some operators trust their paper-based systems more than the computers.

Adapx overcame this challenge under the DARPA SBIR program by developing software that integrates handwriting with standard digital paper and pen technology into commercial software packages used in the field. The multimodal technology enables soldiers and others to create, analyze, process and share handwritten and voice data through commercial software packages for geospatial, technical drawing, design and spreadsheet/form applications.

TECHNOLOGY DESCRIPTION

DARPA Phase II project integrated Adapx's digital pen/paper, sketch recognition, and multimodal technologies, with several military applications, such as the Command Post of the Future and Maneuver Control System. Users were able to speak and sketch on tablet PCs and touch-sensitive surfaces in order to create courses of action or to enter MIL-STD-2525B symbols onto maps rapidly. This multimodal system demonstrated more than an order of magnitude speed advantage over existing graphical user interface methods for military command and control (C2) data entry. Users were also able to sketch symbols on paper maps in the field, with the "digital ink" being entered into C2 systems automatically.

Handwritten data on paper maps automatically integrated in ArcGIS

DARPA then provided Phase III funding from its Advanced Soldier Sensor Information Systems and Technology (ASSIST) and Personalized Assistant that Learns (PAL) programs, and recently, the Deep Green program, to develop recognition methods for the full set of MIL-STD-2525B sketch symbols through sketch alone or multimodal input.

Adapx has further evolved the digital pen/paper technology in its Capturx™ products used to speed data collection for forms, maps, and building plans. Users can:

- Annotate digital paper maps in the field with digital pens that automatically record the data and integrate it into ArcGIS.
- Integrate data collected on paper into commercial software
- Automatically integrate markups on building plans, maps, and other documents in PDF format back into the original PDF files.

LESSONS LEARNED & BEST PRACTICES

- Develop a hybrid business model that addresses both commercial and federal markets.
- Use SBIR funds to develop intellectual property and early prototypes, to support further fundraising and commercial product development.
- Identify and understand all the players in the procurement of new technology.
- Align with prime contractors to be included in programs of record.
- Anticipate the challenge of scaling up to market, sell, and distribute multiple products to enterprises in many geographic locations.
- Align incentives among partners and their employees.

ECONOMIC IMPACT

SBIR funding from DARPA in Phases I, II and III enabled Adapx to develop and patent software technology and adapt it for initial military applications, thus providing the foundation needed for commercialization. With its software proven, Adapx obtained $20 million in venture capital backing from several firms and additional support from strategic partners, such as ESRI, In-Q-Tel, Lockheed Martin, Microsoft and Trimble. The company now has a robust, growing volume of business, with 45 employees as of November, 2009.

APPLICATIONS

The Capturx™ platform is used in numerous applications by more than 500 military; federal, state, and local government; and commercial organizations. Current application areas include defense, intelligence, public safety, retail, energy and mining, healthcare, transportation, utilities and pipelines, and engineering and construction. Examples include in-processing of soldiers; triage, diagnosis, and treatment of injuries; capture of geographic information system (GIS) features automatically into ArcGIS; and completion of forms in Microsoft Excel.

The U.S. Army's Network Enterprise Technology Command (NETCOM) issued a *Certificate of Networthiness* for medical applications of Capturx™ technology, signifying that the software is secure, supportable, sustainable and compatible with the Army enterprise infrastructure.

PARTNERING & COLLABORATION

Recently, in the Deep Green program, Adapx, working with Science Applications International Corporation (SAIC), developed advanced course-of-action generation methods that improve command and control planning and execution. Adapx is now on the BAE team for Deep Green.

Adapx has established important strategic partnerships with a number of large companies. For example, the company is a *Gold Certified Partner* of Microsoft; ESRI awarded Adapx its *New Partner of the Year* award in 2007; and Adapx is an Original Equipment Manufacturer (OEM) provider of digital pen/paper technology to Trimble Navigation. Other partners include In-Q-Tel, which also provided Phase III funding for intelligence applications; Lockheed Martin for military applications; ESRI for ArcGIS; Anoto Group AB for digital pen and paper technology; Oki Data for workflow printing; J.L. Darling for its use of Rite in the Rain all-weather writing paper; and VisionObjects for accurate handwriting recognition technology.

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Topic Name:	**Integration of Information from Heterogeneous Sources**
Topic Number:	**SB922-217**
Contract Number:	**DAAH01-94-C-R156**
DARPA Office:	**IPTO (formerly ISO)**

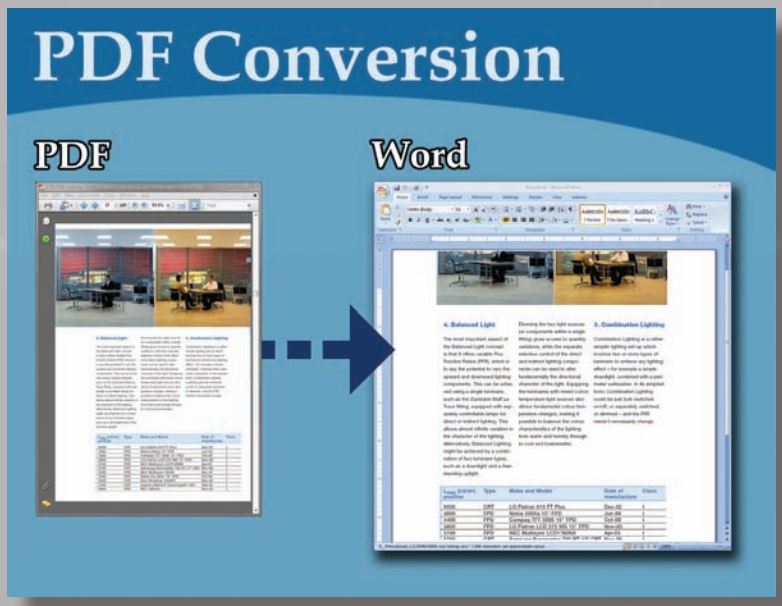
ABOUT THE COMPANY

BCL Technologies, Inc.
Founded 1993 -
Hassan Alam, CEO.
BCL Technologies provides automated solutions that help companies reduce costs and improve productivity for a wide variety of costly manual processes in document creation, conversion, and extraction.

Realized growth from commercial licensing revenue

VALUE PROPOSITION

BCL Technologies developed fuzzy logic mathematical methods to convert previously un-readable text and figures (in financial tables, graphics, and other tabular form) into relational databases, thus reducing the cost of manual data reentry.



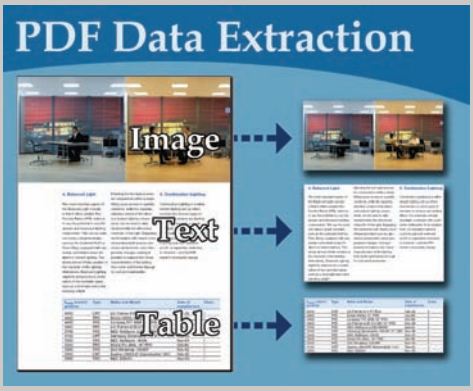
BCL's easyConverter captures formatted information from PDF files and translates them into a rich text format (RTF) or DOC document

TECHNICAL CHALLENGE ADDRESSED

Although the advances in optical character recognition (OCR) have made huge strides in data conversion from paper into machine-readable form, the difficulties of converting data in table format still remain. Many documents in printed, fax, or Portable Document Format (PDF) contain tables that are not machine readable. Expensive, manual data reentry is then required to convert the table into a relational database or other computer-readable form. Several difficult challenges must be overcome to achieve automated extraction and conversion of information from tables or other tabular forms. Table, column and row boundaries must be determined, and sub-tables, headers, footers and captions must be recognized. Data in the table cells must then be isolated from the boundaries, extracted, classified, and then converted to machine-readable form through OCR.

TECHNOLOGY DESCRIPTION

BCL's solutions are based on expertise in neural networks, fuzzy logic, document analysis, information retrieval, database technologies and natural language query processing.



Fuzzy logic extracts image, text and table into a relational database

BCL selected and used the following techniques in the DARPA Phase II project addressing extraction of information from printed pages: fuzzy logic methods reasoning for pattern recognition to detect table, row and column boundaries; perform classification; extract information from the table cells; and store the information in a relational database accessible by Structured Query Language (SQL) software methods.

OCR errors limited data conversion from tables, so alternative extraction methods were developed to replicate and use the table format structure originally employed, including those from PDF engines. These alternative methods allowed machine-readable information to be generated from tables and other structured document elements, such as bibliographies, graphics and financial charts, which are widely used in documents.

The Phase II project demonstration was successful, and BCL continued subsequent SBIR work for DARPA and the U.S. Army, developing technology for management of heterogeneous data and information. BCL was awarded a series of patents in the area of heterogeneous data management, with two of the patents being directly related to the information extraction work initiated at DARPA. Several more patents are pending.

LESSONS LEARNED & BEST PRACTICES

- Recognize that both unforeseen technical obstacles and new opportunities may occur during SBIR projects, so be adaptable and seek approval to shift technical emphasis when a new opportunity offers potential advantages over the existing project direction.
- Target a specific market in Phase II to facilitate early commercialization.
- Consider using a licensing approach, and explore collaboration with an established company.

ECONOMIC IMPACT

Through the DARPA SBIR project, BCL gained the technical expertise, insight, and credibility to win and successfully perform additional SBIR projects from DARPA and the U.S. Army. The commercial licensing revenue from this technology subsequently allowed BCL to weather two recessions and continue on its growth path. The company began on the initial DARPA SBIR work, and based on its commercial business, has grown to 20 people.

APPLICATIONS

To commercialize its patented software, PDF Tools, first BCL targeted the financial sector, where it could focus on extraction and conversion of financial information in tabular form without using OCR. Then the company licensed the software as an add-on plug-in to widely used commercial software packages specializing in format conversions, for extraction and conversion of information in tables. The system is currently used by the U.S. Army and was licensed by Adobe Systems to respond to the Japanese government mandate that financial information in PDF format be converted to machine-readable form.

PARTNERING & COLLABORATION

BCL received several follow-on SBIRs in heterogeneous data and information management. These included a DARPA FaxAssist project to automatically extract the recipient's name from a fax and route it by e-mail, and two Army projects that make documents in various formats accessible on electronic devices, and to provide a knowledge and information management platform.

BCL has partnered with over two dozen financial publishers to automate their data extraction and conversion processes. For example, BCL and RR Donnelley developed the Donnelley Jade software for conversion of PDF files to formats used by the U.S. Securities and Exchange Commission's (SEC) Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system. Donnelley's Jade manager reported that "We have reduced our turnaround times for SEC filings of non-proprietary (CFS and ProFile) by 75 percent." BCL's SEC Publisher is used by many companies for SEC filings with similar results.

Adobe licensed BCL's table extraction technology for Acrobat Table/Formatted Test plug-in 4.0 and 5.0. Another licensee, MS Wireless, used PDF Tools to extract sales order information from PDF files and compare it with data in its point-of-sale database to verify sales, detect fraud, and pay commissions. This resulted in annual labor cost savings of over $500,000 and reduced processing time from 1-2 weeks to 2 days.

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ADVANCED NEUROPHYSIOLOGY FOR INTELLIGENCE TEXT ANALYSIS (ANITA) SYSTEM

DESIGNinteractive

CONTACT INFORMATION

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Topic Name:	**Information Delivery & Display for Shared Awareness in the Net Centric Battlespace**
Topic Number:	**SB052-009**
Contract Number:	**W31P4Q-07-C-C021**
DARPA Office:	**IPTO**

ABOUT THE COMPANY

Design Interactive, Inc.
Founded 1998
Dr. Kay M. Stanney, CEO.
Specializes in engineering, psychology, and software development. Named one of central Florida's top woman-owned businesses by the *Orlando Business Journal* in 2009.

Improved training by tracking eye and brain activity

VALUE PROPOSITION

Neurophysiological tools deliver significant improvements in intelligence analysis and training systems by identifying cognitive information and visual interest.

ANITA used in a flight training system

TECHNICAL CHALLENGE ADDRESSED

Intelligence analysts must sift through vast and complex information sources to identify suspicious patterns and evaluate key snippets of information. The analyst's ability to detect, identify, retrieve, store, correlate and interpret relevant intelligence information can be greatly enhanced by the use of neurophysiological systems that automatically select relevant information based upon the analyst's physical and cognitive state activity levels.

Similar challenges in flight, dismounted, and cultural training applications require development of neurophysiological tools to measure trainees' task performance and provide feedback for improvement. The Design Interactive, Inc. (DI) intelligence and training systems correlate ocular measurements with event-related electroencephalography (EEG) signatures of the brain's electrical activity level to determine the analyst's level of interest and apply classifiers to distinguish correct responses from erroneous ones.

TECHNOLOGY DESCRIPTION

DI developed the Advanced Neurophysiology for Intelligence Text Analysis (ANITA) system as a monitoring tool that observes and measures an analyst's physical and neurological functions during data gathering. ANITA uses a combination of eye tracking and EEG patterns to aid analysts in extracting and processing relevant data from digital files and repositories.

ANITA uses eye tracking and EEG sensors to detect attention focus and evaluate interest

Neurophysiological measures are monitored during the first step of the analysis process - evidence gathering - and ocular fixation points are used to pinpoint visual attention. Cognitive interest is then identified by analyzing associated EEG data using a real-time classification algorithm. Information classified as "interesting" to the analyst is auto-extracted from reviewed documents and stored for further processing during sense making.

ANITA's patent-pending combination of EEG patterns time-synched to ocular fixation substantially enhances evidence gathering by capturing subconscious review of interest that is otherwise unavailable, thereby increasing an analyst's ability to capture more high-priority threats.

LESSONS LEARNED & BEST PRACTICES

- Keep project timelines flexible with Technical Point of Contact in the loop to allow for adoption of new, more optimal design solutions conceptualized throughout the project.
- Use conferences, principal investigator meetings, and other gatherings of potential end users or transition customers to create visibility for an idea or product.
- Evaluate the product for alternative applications domains and additional ways to apply the technology.
- Focus on the big picture. Evaluate how the technology fits a company's strategic vision and how it can be applied to drive or complement other efforts.

ECONOMIC IMPACT

DI's neurotechnology solutions have been supported by SBIR awards starting in 2005 with the first DARPA SBIR Phase I. The patent-pending combination of EEG patterns time-synched to ocular fixations developed under this DARPA award has advanced this technology from concept to adaptive solutions for intelligence and training. As a result of SBIR/STTR projects with Office of the Secretary of Defense (OSD) and Office of Naval Research (ONR) and program funds from Intelligence Advanced Research Projects Activity (IARPA), DI has three related patents pending. The DARPA SBIR was instrumental in developing DI's neurotechnology solutions and revenue generation of $1.2 million. DI is also expanding into a new 8,000 square foot lab and development space in 2009.

APPLICATIONS

DI leveraged its DARPA SBIR and related training evaluation work on the Multi-Axis Performance Interpretation Tool for ONR by developing an aviation training simulation system which was delivered for commercial use in June, 09. This system incorporates DI's methods for eye tracking and behavior detection into the training simulation to assess a trainee's perceptual skills and weaknesses in search and scanning, and cognitive skills in recognition and detection.

In a project sponsored by IARPA and the Air Force Research Laboratory, DI developed a system to enhance an analyst's effectiveness during imagery analysis by increasing both speed of image review and accuracy of threat detection. ANITA is also being transitioned into several military applications, including flight and mission trainers.

PARTNERING & COLLABORATION

DI is partnering with Boeing and Lockheed Martin to transition ANITA to next generation adaptive training systems. A Boeing Flight Simulator used ANITA's neurophysiological measurement component to enable advanced performance measurement, root-cause analysis, and After Action Review resulting in a more thorough and targeted training system. Lockheed Martin Complex Mission Environment Testbed used ANITA to provide real-time cognitive state and performance feedback that enable learner-adaptive and customized training solutions.

DI has also evolved this technology into a real-time, closed-loop Auto-Diagnostic Adaptive Precision Training framework that has spawned SBIR efforts to further mature the technology and apply it to agency specific problems:

- perceptual-skills adaptive trainer for OSD
- decision-making adaptive trainer for ONR

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OPEN SOURCE INFORMATION GEOSPATIAL OVERLAY (OSIGO)

CONTACT INFORMATION

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Topic Name:	**Open Source Information Geospatial Overlay (OSIGO)**
Topic Number:	**ST071-005**
Contract Number:	**W31P4Q 07-C-0261**
DARPA Office:	**AEO**

ABOUT THE COMPANY

Geosemble Technologies Inc.
Founded 2004 - Andre Doumitt, CEO. Provides automatic techniques for extracting and fusing geospatial data sets, including maps, aerial imagery, lists, events, databases, business information and other data. Spun off from University of Southern California (USC).

Increased commercial revenue by approx. 30%

VALUE PROPOSITION

Geosemble's OSIGO tool automatically and rapidly links designated features or points on satellite images with geospatially related open-source data to accelerate and improve use of disparate, yet related information to support analysis and improved decision making.

TECHNICAL CHALLENGE ADDRESSED

Satellite imagery and aerial maps contribute their greatest value in military, intelligence and commercial applications when rapidly linked with online information, news, intelligence reports, text documents, videos and other open-source datasets. Current manual or semi-automatic methods for linking datasets are expensive and time consuming. In addition, imagery and datasets collected at different times typically do not have identical resolutions, projections, precisions or accuracy. Thus, correlating open-source datasets to a precise point on an image or map was difficult, and once correlated, there were no methods to summarize information. The technical challenge undertaken by Geosemble was to develop and apply automatic, scalable methods to find, correlate and assign open-source datasets to a specific feature or point on an image or map and provide summary information to enhance a user's interpretation and decision making.

TECHNOLOGY DESCRIPTION

Geosemble developed a set of innovative geospatial reasoning methods for rapid and automatic alignment and linkage of open-source information to satellite imagery and aerial maps. Under a complimentary Air Force STTR, the company developed compilation and reconciliation methods (conflation) of satellite imagery and raster maps to align and correlate roads and parcels between the two data sets.

Rapid alignment and linkage of open source information enhances data interpretation and enables end-user ability to make better decisions in support of operational or commercial objectives. The system allows an analyst to view a satellite image of any place in the world, automatically find and link geospatially related documents, and then browse a summary of the documents. In particular, the system enhances the richness of maps by including features such as road names, parks, streets and information on buildings automatically and accurately on top of satellite imagery.

The system can be used as a stand-alone tool or integrated within a larger suite of software. For assignment of text data to aerial imagery, the system builds on the aligned vector layers with a patent-pending automated analysis, correlation and assignment process that applies geospatial reasoning in the area of interest to accurately identify and link data pertaining to a specific point in the image. This process also scales well and can be done on-the-fly thus enabling users to automatically link a wide range of data to specific points on an image. Such rapid and accurate geospatial linking gives users a quick, deep understanding of the depicted scene for enhanced interpretation. No International Traffic in Arms Regulations (ITAR) restrictions have been applied to the software.

LESSONS LEARNED & BEST PRACTICES

- Have key military or commercial applications for the technology in mind as a starting point for writing an SBIR Phase I proposal.
- Define and validate the user's application during Phase II prototype development, to ultimately guide integration of technology into operational environments. The initial Geosemble technology application was changed as a result of end-user feedback obtained during the validation process.
- Have at least one person on your team responsible for coordinating all activities associated with validating, refining and pursuing DoD or other federal and commercial applications.

ECONOMIC IMPACT

The SBIR project has had a significant economic impact on Geosemble's growth and success by establishing the company's credibility as a viable small business partner and as a thought leader in this domain. Other significant outcomes:

- Based on user needs assessments, Geosemble designed and developed a commercial Graphical User Interface that showcased the system's functionality for municipal users and for the broader commercial marketplace
- Sold system to two U.S. municipalities - Culver City and El Segundo, California
- Increased commercial revenue by approximately 30 percent
- Secured an investment from In-Q-Tel to mature and commercialize technology
- Secured additional government contracts from DoD and Intel amounting to 150 percent of company's annual revenues to date
- Awarded Phase II AF and Phase II DARPA funding
- Secured a partnership with a Prime Defense supplier to pursue additional federal contracts

APPLICATIONS

Geosemble's technology can be applied to both government and commercial markets. The U.S. Intelligence Community is currently using the company's OSIGO-based GeoXray product. U.S. municipalities are also using the software to showcase the assets within the region to support redevelopment initiatives focused on attracting business to those cities. For example, the City of El Segundo, California has launched an application that allows users to see news for specific points on maps or aerial imagery. Users can click on an object such as a building, see what business is there and read news about the business.

PARTNERING & COLLABORATION

Geosemble partnered with the USC to support the natural-language processing (NLP) component of its tool which is required to automatically cluster and summarize the text linked to a geographical location. The company also worked with the City of Culver City, CA to define user requirements and use cases before developing the system. In collaboration with USC, the company integrated Department of Homeland Security (DHS) Phase I program technology in dealing with point-location data to achieve a useful combination for both government and commercial customers.

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NON-INTRUSIVE HEALTH AND WELLNESS MONITORING

Healthsense®

CONTACT INFORMATION

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www.Healthsense.com

Topic Name:	**Non-Intrusive Health Monitoring for Post-Battle Wellness Management**
Topic Number:	**05SB2-012**
Contract Number:	**W31P4Q-06-C-0223**
DARPA Office:	**IPTO**

ABOUT THE COMPANY

Healthsense, Inc.
Founded 2005 - Brian J. Bischoff, CEO. The mission of Healthsense, Inc. is the effective delivery of emerging sensing and automation technologies that address national concerns and provide advances in patient safety, quality of life, and reduction of health care costs.

NY Times features user testimonials on the benefits of eNeighbor® system

VALUE PROPOSITION

A health and wellness monitoring system that keeps the elderly and impaired in their homes longer, provides a better quality of life, and reduces healthcare costs.

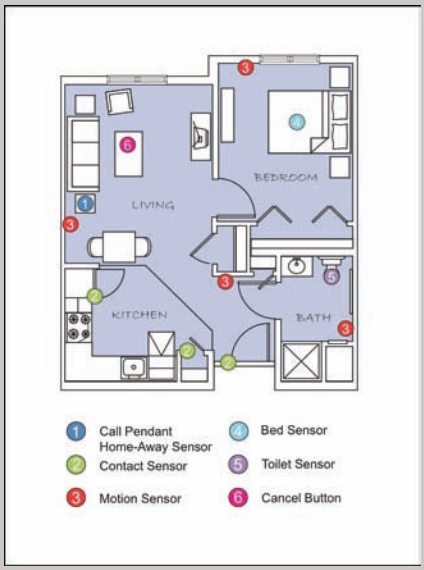
Sensors with Wi-Fi Access Point

TECHNICAL CHALLENGE ADDRESSED

The Department of Veterans Affairs will face enormous challenge in caring for aging, injured, and impaired veterans in that about 40% of the nation's veterans (compared to 12% of the general population) are age 65 and older. Increasing numbers of the elderly and physically impaired find it necessary to move from their homes to assisted-living or retirement homes and then to skilled nursing facilities. The forced transition of individuals to escalated levels of care results in a 2- to 4-time increase in healthcare costs and a reduction in quality of life. Medicaid spent $99.9 billion for long-term care in 2008 and this will increase dramatically since the population over age 65 is expected to grow from 35 million in 2000 to 80 million by 2050. These demographics and projections create an imperative for cost-effective technology to monitor the health and wellness of the aged or impaired so they can enjoy more independence at home or remain longer in lower-level care facilities. A broader challenge is to foster initiatives that lead to wider adoption of cost-effective wellness monitoring systems while ensuring sound protection of patient data.

TECHNOLOGY DESCRIPTION

The Healthsense eNeighbor® system, initiated with SBIR funding from DARPA and the NIH, integrates more than a dozen Wi-Fi enabled sensing devices to monitor the activities of individuals, notify caregivers when a significant change in patient routine occurs, provide insight and information for follow-up, and establish the basis for tailoring care plans. Users and care providers codify an individual's daily routine into an interactive database which utilizes a variety of sensor information to monitor an individual's activities, identify problems and automatically alert care givers in accordance with predefined criteria.



Example floor plan showing sensor locations

In addition to alerts, the system provides assistive prompts reminding individuals to complete and automatically report on essential tasks (such as taking vital signs, recording weight, or taking medications) which are relayed to caregivers. Data depicting an individual's physiology, daily activity patterns, monitored events, and alert notifications are maintained in a secure data center that authorized users access via a secure web portal. The eNeighbor system also features a robust, unified software platform that manages the entire system from sensors and wireless network to the data center by collecting status information, running diagnostics, and prescribing maintenance actions. Certification by the Wi-Fi Alliance signifies a commitment to secure, open standards and facilitates wide-spread implementation.

LESSONS LEARNED & BEST PRACTICES

- The SBIR program is an excellent funding mechanism to support research activities that are critical path in a company's strategic plan to develop new products.
- Only pursue SBIR project, or grants in general, that are aligned to your company's strategic plan.

ECONOMIC IMPACT

SBIR funding was vital to the initial development of the eNeighbor system and to the growth of Healthsense. The SBIR funding helped to create 24 jobs within Minnesota. Five patents have been issued and six patents are pending. SBIR funding was also instrumental in attracting venture capital funding.

On the national scale, major savings in medical care assistance costs appear likely by using monitoring systems to keep individuals in their homes or lower-level care facilities for longer periods but additional study is needed to determine the full magnitude of the savings.

APPLICATIONS

Applications made possible for this technology that improve quality of life and reduce health care costs can be appreciated by examining the costs incurred through the various stages of the long-term care continuum. To reduce the financial burden of delivering long-term care, healthcare providers, payers, families, and older adults are turning to monitoring solutions to slow progression through the care continuum, lower costs, and improve quality of life.

PARTNERING & COLLABORATION

Care providers who have successfully deployed the eNeighbor system include Masonicare, Lutheran Homes, Northfield Retirement Community, Meridian Health, and Fairview Ebenezer. At the Northfield Retirement Community, the system is used to monitor Alzheimer's disease and dementia patients.

A New York Times article included user testimonials on the benefits of the eNeighbor system. A 78-year-old woman with diabetes fell and was unable to call for help. Motion detectors in her home notified the central monitoring center that she was outside her prescribed pattern and dispatched firefighters. The at-home system costs $100 per month vs. $200 per day at a nursing home. An 86-year-old retired Air Force lieutenant colonel, has used the system in his home since 2006. For $20 per month, the system records his vital signs and provides daily voice prompts that inquire about his physical well being (i.e., breathing ability, whether his ankles are swollen). The system has allowed him to remain in his home of 37 years. A daughter receives feedback that her father is in compliance with his medication schedule.

The Department of Veterans Affairs contracts with approximately 2,500 nursing homes. In fiscal year 2003, approximately 70% of the department's institutional nursing home care occurred in these nursing homes.

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J.A. Woollam Co., Inc.
Ellipsometry Solutions

CONTACT INFORMATION

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www.jawoollam.com

Topic Name:	**In-Situ Process Sensors for Real-Time Microcircuit Manufacturing Control**
Topic Number:	**SB901-028**
Contract Number:	**DAAH01-92-C-R222**
DARPA Office:	**MTO (formerly ETO)**

ABOUT THE COMPANY

J.A. Woollam Company, Inc.
Founded 1987 -
Founder & CEO, Dr. John A. Woollam.
Offers a complete line of spectroscopic ellipsometer products, covering a wide spectral range, to measure thin film depositions for many products and applications.

Leader in spectroscopic ellipsometry from multiple SBIRs

VALUE PROPOSITION

J.A. Woollam's spectroscopic ellipsometry methods monitor and control the deposition of optical thin film coating during manufacturing, enabling the production of semiconductors, lasers, infrared sensors, waveguides, and other devices with better performance and lower cost.

Key technology for M-44 involved accurate parallel collection of multiple wavelengths (colors) with a Diode-Array detector (new IP at time of this contract)

TECHNICAL CHALLENGE ADDRESSED

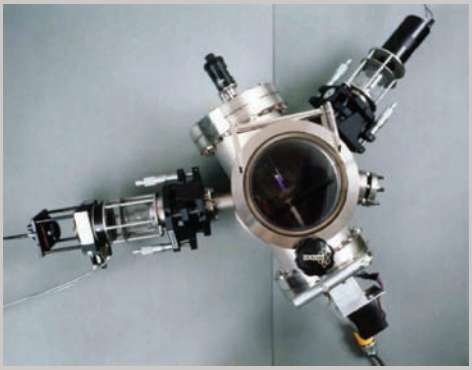
U.S. military weapons, intelligence, and communications systems employ a variety of electronic devices where performance, reliability and cost depend on the ability to precisely control the growth of their optical thin film coatings during manufacturing. As measurement and control of thinner and thinner coatings became more challenging, use of spectroscopic ellipsometry (SE) methods appeared promising if SE optical devices could be intergated with the deposition chamber to measure changes in polarization as light reflected from the coating being deposited. Existing bulky optics for SE were modified and inserted into the thin film manufacturing process chambers to detect required optical wavelengths in sequence, and then the optics were further enhanced to detect 44 wavelengths simultaneously and achieve real-time measurement and control.

J.A. Woollam built on 3 DARPA SBIRs to evolve and refine SE technology into a family of products that is now widely used within the semiconductor industry.

TECHNOLOGY DESCRIPTION

In the initial DARPA work, J.A. Woollam modified an existing, ex-situ variable angle spectroscopic ellipsometry (VASE) tool to achieve in-situ measurements on a molecular beam epitaxy (MBE) growth chamber. Significant improvements to the data acquisition and analysis software allowed successful in-situ characterization of aluminum gallium arsenide layers grown by MBE.

Subsequent SBIR work for DARPA and other agencies resulted in the development of a real-time spectroscopic ellipsometer to monitor and measure the thickness of film deposition in real time. To overcome the slow scanning speed of the VASE monochromator, an entirely new SE technology was developed that collected all wavelengths in parallel, using a diode array detection system. This new technology was the key to collecting 44 wavelengths at the same time rather than the single-wavelength of VASE technology. It increased the data content during in-situ growth. Real-time feedback control was demonstrated during electron-beam deposition of silicon oxynitride and mercury cadmium telluride films during metalorganic chemical vapor deposition growth. Based on work under the multiple SBIR projects, the company developed a whole family of SE products to meet a variety of needs:



In-Situ VASE (about 1992)

- VASE®, with a spectral range of 193-2500 nm
- M-2000®, with revolutionary rotating compensator technology and a spectral range of 193-1700 nm
- IR-VASE®, with a spectral range of 2-30 microns
- alpha-SE®, a low-cost system for measuring index and thickness in the spectral range of 380-900 nm
- AccuMap-SE®, a high-speed M-2000 with fast mapping for characterizing the thin film uniformity of large panels

LESSONS LEARNED & BEST PRACTICES

- Identify and develop applications for specialized measurement tools as an important part of commercialization.
- Build customer awareness of the technology and applications by joint publications with researchers and presentations at technical conferences.
- Consider patents on technology as a commercialization strategy to maintain a dominant position in the market.

ECONOMIC IMPACT

When the DARPA SBIR work began, the J.A. Woollam Company had fewer than 10 employees. With the help of three successful SBIR projects, the company has grown to over 40 employees, developed a family of products, and achieved world-wide sales. J.A. Woollam is now recognized globally as a leading spectroscopic ellipsometer company, with over 90 patents and world-wide sales of nearly 2000 spectroscopic ellipsometers. The reputation of the company in hardware and software products, customer support, and applications development has been key to its place as a leader in the ellipsometry community.

APPLICATIONS

The semiconductor industry depends on lithography for manufacturing tasks that require SE measurements in the ultraviolet region. The display industry uses the visible spectrum, and the telecommunications industry uses the near infra-red spectrum. J.A. Woollam's SE products cover the spectral range from 33 microns to 140 nm, and this range spans the required wavelengths required to measure thin film depositions across this entire scope of products and applications.

PARTNERING & COLLABORATION

The roots of J.A. Woollam began in the early 1960s at the University of Nebraska, Lincoln (UNL), where ellipsometry work was undertaken in the Electric Material Laboratory. Over 80 papers were published by professors and students in the '60s and '70s, and early ex-situ VASE ellipsometers were developed.

John Woollam arrived at the University in 1979 to extend the previous ellipsometry work in the UNL laboratories. In 1987, he founded a separate company in collaboration with UNL—staffed with UNL graduates—to develop and sell a commercially viable ellipsometer on a small volume basis. The company received its first DARPA SBIR funding in 1988 to develop the SE technology needed for the thin films being used in military and commercial electronic devices.

The company's SE products were developed from the technology advancements made possible through funding from DARPA and over a dozen subsequent SBIR Phase I and II projects from the Army, Air Force, and National Science Foundation, along with internal funding generated from commercial product sales. J.A. Woollam collaborates with many companies for sales activities in over a dozen countries. The ellipsometers are offered as sensors on many deposition chambers provided by companies such as Oxford Instruments (atomic layer deposition chambers) and Von Ardenne (in-line sputter and evaporation chamber).

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Kinetic Art & Technology

CONTACT INFORMATION

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Ph: (812) 923-7474 • Fax: (812) 923-8777
www.katech.com

Topic Name:	**Lightweight, Intelligent Speed Reducers and Controllers**
Topic Number:	**ARPA 92-222**
Contract Number:	**DAAH01-94-R224**
DARPA Office:	**MTO (formerly TTO)**

ABOUT THE COMPANY

Kinetic Art & Technology
Founded 1990 -
CEO and President, Roy Kessinger.
Kinetic Art & Technology (KAT), formerly Visual Computing Systems, develops concepts, techniques, and designs for highly efficient and compact electromechanical systems utilizing its proprietary SEMA motor/generator technology.

Licensing SEMA Motors for Multiple Applications

VALUE PROPOSITION

Kinetic Art & Technology applied segmented electro-magnetic array (SEMA) technology to produce motors and generators with higher and faster torque; better efficiency; smoother control; lower noise; smaller size; and simpler, modular components for efficient manufacturing.

SEMA traction motor for DOE Future Truck project

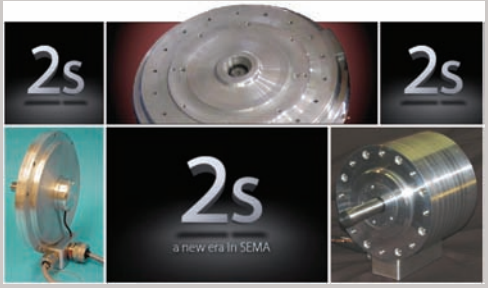
TECHNICAL CHALLENGE ADDRESSED

The DARPA SBIR project developed revolutionary new motor technology to overcome the physical and performance limitations of conventional direct drive motors used for robotics and other servomotor motion control applications, such as magnetic resonance imaging (MRI), spacecraft turbines, thrust vector control, autonomous underwater vehicle propulsion, motor/alternator for hybrid electric vehicles, and constant velocity motors for applications where smooth, precise control is necessary. Conventional motors or gear motors do not provide smooth motion control, and at high loads their efficiency decreases. Also, their torque output is not the desired smooth, linear, proportional function of the amount of current applied. The SBIR challenge was to eliminate these limitations by developing a new type of SEMA motor with revolutionary coils and stators, designed to provide smooth, high torque motion and speed control along with economical manufacturing methods.

TECHNOLOGY DESCRIPTION

SEMA technology was developed and demonstrated under the DARPA SBIR and was further developed and applied to a variety of applications through subsequent SBIRs, STTRs, a spin-off company, and private funding.

SEMA technology is based on an axial gap (disk) direct current motor without brushes or contacts to wear out, spark, or cause losses. It employs a permanent magnet that produces a magnetic field in a specially designed coil inside an ironless stator that is segmented into groups of pole-pairs. These innovations eliminate phase mutual inductance, magnetic saturation of the iron core, and hysteresis or lagging in magnetization when the amount of current is varied; and reduce resistance losses in the coil wires while avoiding torque pulsations. The results are higher power density, superior efficiency, faster and smoother response, better control, higher torque at low-speed operation, and reduced noise, as compared to conventional motors.



Aerospace ElectroMechanical Actuators powered by SEMA technology

Motors based on SEMA architecture may be operated at constant or variable speed, or reversed in a steady or intermittent state, and can be controlled precisely in a quiet, continuous manner. SEMA motors provide extremely high peak torques, and SEMA generators provide extremely high peak currents. They eliminate torque oscillations (cogging) and minimize low torque ripple. Independent tests demonstrated efficiency as high as 98 percent. SEMA motors and generators range from 3 to 33 inches in diameter and from fractional to 200 horsepower output. They are easier to manufacture than conventional motors, since they are modular and entail simpler coil and stator designs. SEMA machines are best suited for applications where efficiency, size, weight and smooth operation are important.

LESSONS LEARNED & BEST PRACTICES

- Understand the value of marketing in a small, innovative company, and present proposition in technical and business terms.
- Technology licensing is a time-honored and proven approach to leverage the innovation of a small company while capitalizing on the production and marketing capabilities of a larger company.
- Develop a mutually effective relationship with a larger potential partner that bridges differences in culture and practices, and provides an excellent return on investment for both companies.

ECONOMIC IMPACT

Based on its initial DARPA SBIR success, has received more than 20 SBIRs and STTRs from federal agencies, including the Department of Defense (DoD), National Aeronautics and Space Administration (NASA), and Department of Energy (DOE).

The SEMA technology is patented. A sister company, Lynx Motion Technology, was formed to license SEMA for manufacturing, and several other companies sell the technology under license agreements. Private investment and development funding continues to flow to develop SEMA technology and related products.

APPLICATIONS

SEMA motors and generators have been in production since 1999 for a wide variety of applications, which include magnetic resonance imaging control; aerospace applications, such as spacecraft turbine replacement and thrust vector control; autonomous underwater vehicle propulsion; motor/alternator for hybrid electric vehicles; constant velocity motors for various commercial applications; and a servo motor for an industrial welding robot with over one million cycles of endurance testing.

PARTNERING & COLLABORATION

The DOE projects include providing a SEMA traction motor for an electric hybrid vehicle under the Future Truck program, and grants for other automotive applications and research activities. KAT was a recipient of a 2000 Tibbetts Award from the Small Business Administration for its SBIR/STTR success.

KAT received a $267,000 SBIR/STTR Commercialization Enhancement Program grant from the State of Indiana to commercialize its proprietary CL1 Controller. The company also received a $1.9 million grant from the Indiana 21st Century Fund to develop and commercialize advanced SEMA technology, working with Honeywell Aerospace. The two companies are jointly developing multi-slice motors (each slice is a motor), in which slices are electrically separated but working together mechanically to provide flexibility and redundancy.

KAT's subsidiary, Lynx Motion Technology Corporation, has established strategic business partnerships and relationships with several commercial companies. Bodine Electric Company is licensed to manufacture its e-TORQ™ motors, while several other companies are licensed to sell SEMA motors and generators. SEMA licensee, Lexel Imaging Systems, developed and delivered a propulsion motor for a Navy unmanned undersea vehicle in August of 2008.

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HIGH PERFORMANCE LASERS FOR RADIO FREQUENCY PHOTONICS APPLICATIONS

Multiplex, Inc.
Photonics for Communications

CONTACT INFORMATION

5000 Hadley Road
South Plainfield, NJ 07080
Ph: (908) 757-8817 • Fax: (908) 769-4288
www.multiplexinc.com

Topic Name:	**Low Cost, High Performance Lasers for RF Photonics Applications**
Topic Number:	**SB991-006**
Contract Number:	**DAAH01-00-C-R195**
DARPA Office:	**MTO**

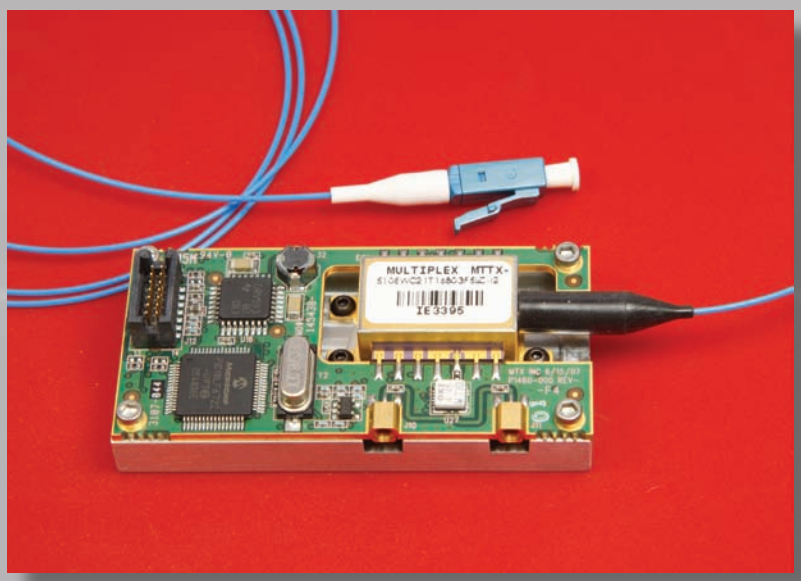
ABOUT THE COMPANY

Multiplex, Inc.
Founded 1998 -
CEO and President, Dr. Won T. Tsang.
Multiplex, Inc. is one of the world's leading manufacturers of high-end active photonic components and subsystems for next-generation optical networks.

Electro-absorption modulated laser transmitters enhance telecommunications

VALUE PROPOSITION

Multiplex produces high speed, low noise, ultra-compact optical transmitters by monolithic integration of a semiconductor laser and an electro-absorption modulator on a single chip.



A wavelength tunable optical transmitter with an EA Modulated Laser module inside

TECHNICAL CHALLENGE ADDRESSED

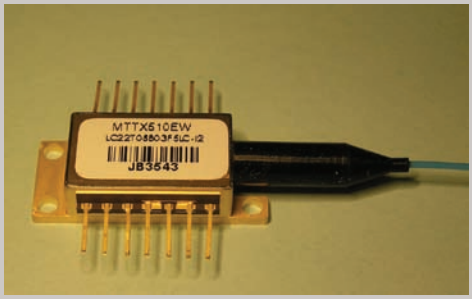
The DARPA SBIR project was initiated to reduce manufacturing costs and overcome performance limitations in lasers used in photonic transport of analog radio frequency (RF) signals in communication, radar, and other RF signal-processing systems operating at high modulation speeds. New technology was required to develop and tightly integrate semiconductor lasers with advanced modulation methods to produce low cost, robust, high performance optical transmitters. Production called for new manufacturing methods. Essential performance measures for the optical transmitters included high modulation bandwidth, low relative intensity noise (RIN), and miniaturizing the integrated laser and modulator to 300 x 500 micrometers with low weight and power consumption.

Meeting these challenges resulted in a foundry for manufacturing the new optical devices, technology for additional applications, advanced waveguide techniques for avionics, and a business based on the family of resulting laser products.

TECHNOLOGY DESCRIPTION

Under the DARPA Phase II work, modulation doped multi-quantum well (MQW) distributed feedback (DFB) lasers were fabricated and their performance characteristics measured. These tests showed low threshold current; high slope efficiency; and high output power. The measured RIN decreased with increasing current, yielding an improvement of approximately 20 dB and resulting in lower values than those for regular MQW lasers.

The DFB laser was monolithically integrated with an electro-absorption modulator (EAM) on a single InGaAsP/InP chip, with the resulting package being much smaller than a hybrid packaged laser with an external modulator. An innovative selective area growth (SAG) metalorganic chemical vapour deposition (MOCVD) method was used for monolithic integration of the laser and EAM. The SAG method is a band-gap engineering technique that was developed for the epitaxial growth of the MQW laser and the EAM in the same MOCVD run. This method grows the epitaxial layers by chemical reaction rather than physical deposition. It simplifies single-chip photonic integration and has become the dominant process for manufacture of laser diodes, solar cells, and light-emitting diodes (LEDs). Low device yield of EAM lasers (EML), an issue at that time, was overcome using this technique. The DFB laser, the integrated DFB laser with modulator, and later a tunable distributed Bragg Reflector (DBR) laser with integrated modulator all met design goals in RF photonic transmission experiments and 10 Gb/s optical fiber transmission systems.



Integrated DFB laser and EA modulator in a fiber packaged module

Subsequently, Multiplex, Inc. developed methods to monolithically integrate an injection locked laser with an electro-absorption modulator under an Air Force SBIR project. The company also has successfully developed a custom compound semiconductor foundry service that produces a family of company products based on EAM and MOCVD technologies.

LESSONS LEARNED & BEST PRACTICES

- Identify realistic market opportunities and technologies or products based on company capabilities and resources.
- Seek SBIR funding to develop promising high-risk and high-reward technology.
- Establish and manage clear, realistic program goals, approaches, schedules, and resources; and use effective risk mitigation techniques.
- Identify commercialization paths in Phase I, and pursue them early and aggressively in Phase II.

ECONOMIC IMPACT

The DARPA SBIR work helped spawn the use of EML optical transmitters for telecommunication systems and opened up growth opportunities for Multiplex, Inc. The company's staff grew from fewer than 40 to more than 200, and achieved significant growth in revenue from sales of optical components and products. The company also received funding for related Air Force SBIR work, from DoD prime companies, such as Lockheed Martin, and secured funding from several commercial investment firms. These successful initiatives have given Multiplex, Inc. a prominent position in the optoelectronics industry.

APPLICATIONS

EML transmitters are now used for many applications in telecommunication networks because of their superior performance over directly modulated lasers. Products include high-speed EML-based lasers operating at 10 Gb/s, high-sensitivity photo receivers, tunable EMLs, and transponders that integrate both tunable EMLs and photo receivers with multiplexing devices. The latter integration, for example, enables wavelength routing and conversion for reconfigurable networks in a more compact package than other devices.

PARTNERING & COLLABORATION

This DARPA SBIR program was conducted in collaboration with the University of Connecticut. University personnel performed testing to measure the performance characteristics of the modulation doped laser devices developed during the project.

The Air Force Research Lab funded a subsequent SBIR project to integrate EA modulation with a DFB laser by MOCVD methods for an ultra-high speed monolithic injection-locked analog transmitter array (MILATA) used for laser detection and ranging (LADAR) sensors and scene generation. The LADAR scans large areas, processes a 3D image of the scene, and compares the image with 3D target files to identify targets and select the best attack position. The Air Force MILATA work demonstrated the LADAR device concept, but packaging the devices requires extensive funding, which thus far has not materialized.

Multiplex, Inc. is collaborating with Lockheed Martin in the development of tunable EML transmitters for avionics in a program funded by the U.S. Air Force.

Several venture capital investments were received, and along with product sales, allowed Multiplex, Inc. to develop a semiconductor foundry and a family of products for military and commercial use. Multiplex, Inc. also has relationships with a number of equipment suppliers.

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NON-INVASIVE HYDRATION MONITORING

PhiloMetron, Inc.™

CONTACT INFORMATION

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San Diego, CA 92121
Ph: 858-638-7801 • Fax: 858-638-7814
www.philometron.com

Topic Name:	**Non-Invasive Physiological Monitoring**
Topic Number:	**SB041-012**
Contract Number:	**W911NF-05-C-0071**
DARPA Office:	**DSO**

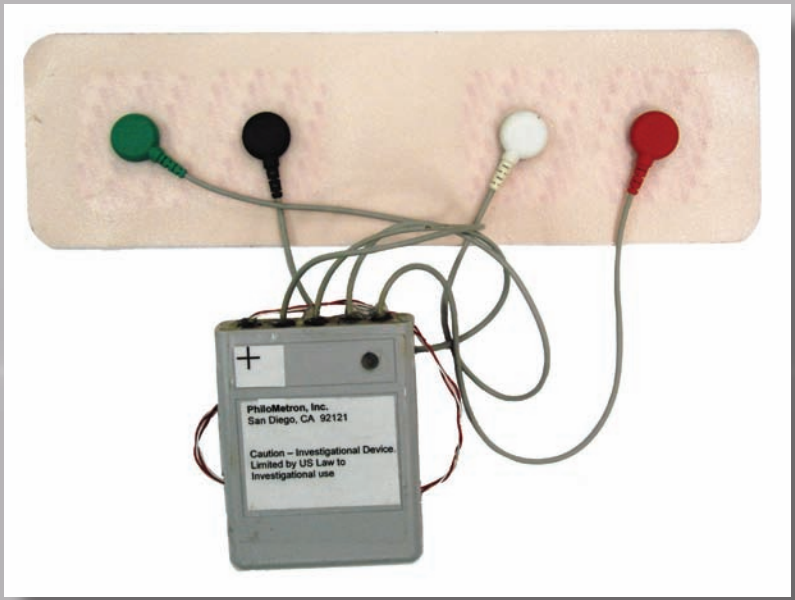
ABOUT THE COMPANY

PhiloMetron, Inc.
Founded 2000 - Darrel Drinan, CEO. PhiloMetron is a healthcare company developing proprietary wireless diagnostic and therapeutic solutions, providing higher quality physiological information that are focused on improving the quality and lowering the cost of human health management.

Spinout companies raised more than $50 million

VALUE PROPOSITION

Preventing dehydration and heat stress in ambulatory soldiers through remote human sensing.



A wearable, non-invasive, ambulatory hydration monitoring system

TECHNICAL CHALLENGE ADDRESSED

Warfighters must maintain adequate levels of hydration to retain their physical and cognitive skills in combat and training environments. Low levels of hydration affect cognitive perception and decision making, impact overall physiological performance and can even jeopardize survival. Consequently, it is essential that hydration levels be continuously monitored and alerts be provided to warn of low hydration levels. Prior to PhiloMetron's work on this DARPA SBIR, the primary methods available to measure dehydration used point-in-time diagnostic sampling methods to measure body weight, plasma osmolality, or urine osmolality. Plasma and urine osmolality measure the amount of solutes, such as salt, in the fluids. Such point-in-time diagnostic methods are impractical for applications where the person is ambulatory. Instead, methods that provide continuous, real-time detection and warning of a dangerous dehydration level are needed.

TECHNOLOGY DESCRIPTION

Prior to the successful completion of PhiloMetron's SBIR project (2004-2006), a wearable, non-invasive, ambulatory hydration monitoring system with a clinical sensitivity of less than 500 ml had not been successfully developed and validated. Detection of hydration changes of less than 500 ml sensitivity is critical in order to allow proactive re-hydration prior to serious physical or cognitive performance degradation. A typical military recruit may experience fluid loss as high as one to two liters per hour in training exercises preparing for combat.

A wearable, non-invasive, ambulatory hydration monitoring system

During the two phases of this SBIR award, PhiloMetron developed and clinically validated an ambulatory hydration monitoring platform with the requisite sensing technology algorithms to enable use in a combat environment. The monitoring platform sensing technology measures the change of tissue hydration (fluids) in the lower chest region and was validated in this program to be highly correlated with the overall systemic hydration change. The monitoring system is sensitive enough to detect the onset of dehydration and provide alerts in sufficient time to avoid performance degradation and possible heat stroke.

Volunteers for the clinical study were selected from civilians reflecting the U.S. military recruit population. The study was conducted at a private, professional sports training facility. Several patents covering numerous applications in military and commercial markets were filed prior to the study. The monitoring platform is contained in a patch that may be worn for periods up to seven days. Additional sensors for such physiological functions as heart rate, temperature, motion, blood oxygen, etc. can be integrated, as required, for various applications. Physiological data can be transmitted by wireless methods to a local data collection and display unit (e.g., a cell phone or personal digital assistant [PDA]-like device) to alert the user or a third party of the need to take immediate, responsive action.

LESSONS LEARNED & BEST PRACTICES

- To increase volunteer recruitment rates, use recruiters of the same ethnicity as the ethnic cohorts being sought for the study.
- Allow sufficient time (nine months in PhiloMetron's case) to receive medical protocol approval from the cognizant clinical study protocol human subject safety review board.
- Delay the creation of a commercialization spinoff company until the technology is sufficiently ready for a marketable product.

ECONOMIC IMPACT

- Successfully created spinoff companies that use the technology developed in this program and employ more than 60 people.
- Raised more than $50 million in venture capital investments for these spinoffs.
- Credibility gained from successful financing of spinoffs enhances the company's ability to obtain future financing.

APPLICATIONS

In addition to military applications, PhiloMetron's ambulatory hydration monitoring platform can be used to monitor and alert firefighters, athletes, the elderly, and patients in hospitals. The company's platform has been integrated into a congestive heart failure (CHF) monitoring system, which detects excess fluid accumulation in patients.

The platform is also being applied into a system addressing fitness and obesity. This system inputs physiological measurements to algorithms that calculate a person's caloric intake and expenditure. The system was validated through post-hoc analysis of the clinical study data.

PARTNERING & COLLABORATION

PhiloMetron's commercialization approach is to create spinoff companies to market its technologies for specific, targeted applications. Two spinoff companies have been established that apply technology derived from the DARPA SBIR work in the CHF monitoring and obesity/fitness markets.

For the CHF market, Corventis™ (www.corventis.com) offers an ambulatory monitoring platform that integrates technology for physiological sensing, wireless transmission, and Web services. Web services provide a hosted application for data analysis and storage, and a Web site for physiological trends and clinical information to aid in interpretation and diagnosis. When the system detects an abnormal event, it collects and sends the measured physiological data, e.g. electrocardiogram (ECG) etc. to one or more authorized persons. The company is distributing this system through cardiologists and hospitals.

Another spinoff company yet to be named officially, is integrating the hydration monitoring technology into an obesity/fitness application to provide a substantially more accurate and algorithmically derived measurement of caloric intake and expenditure. The system provides metabolic data to assist athletes and dieters in meeting their training and weight-management goals.

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LIGHTWEIGHT ELECTRONICALLY STEERABLE ANTENNA

CONTACT INFORMATION

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Ph: 978-562-3866 x255 • Fax: 978-562-6277
www.radanttechnologies.com

Topic Name:	**Microelectromechanical Systems (MEMS) Demonstration Radar System**
Topic Number:	**SB962-069**
Contract Number:	**DAAH01-97-C-R189**
DARPA Office:	**STO**

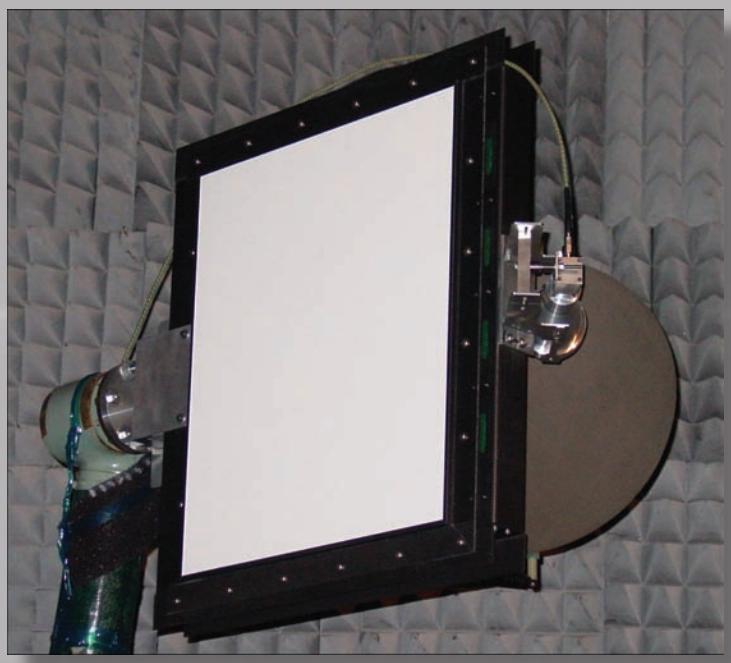
ABOUT THE COMPANY

Radant Technologies, Inc.
Founded 1979 - Jean-Claude Sureau. The Radant Group, with headquarters in Stow, Mass., is comprised of Radant Technologies, Inc., a world class manufacturer of advanced composite radomes and antennas; and Radant MEMS, Inc., the manufacturer of the world's most reliable MEMS switches and devices based on known lifetimes test results.

Launched 9 commercial off-the-shelf MEMS switch products

VALUE PROPOSITION

Low-cost, lightweight, low-power, highly reliable steerable radar antennas for detection of moving air or ground targets.



0.4 m2 MEMS Electronically Steerable Antenna in Test Chamber

TECHNICAL CHALLENGE ADDRESSED

Radant Technologies, Inc. was awarded a DARPA Phase I SBIR project in 1996 and successfully developed proof of concept using Microelectromechanical Systems (MEMS) technology for a lightweight electronic steerable antenna (ESA) that would cost less, consume less power, perform better than existing antenna technology and interface with radar systems that detect air and ground targets. The Air Force Research Laboratory (AFRL) then funded a follow-on SBIR for a demonstration MEMS ESA system for an X-band radar system. A MEMS array can replace mechanical or semiconductor-based phase shifting antenna steering methods to control the radiation pattern and scan the radar beam electronically. Radant built a 2-foot by 2-foot lens containing 25,000 MEMS switches and demonstrated it at Lockheed-Martin in 2006. The standard mechanically scanned antenna in an APG-67 X-band radar was replaced by the Radant MEMS ESA, interfaced to the radar, and met military performance expectations.

TECHNOLOGY DESCRIPTION

MEMS ESA achieves a three to tenfold savings in weight, prime power and cost. It contains 25,000 MEMS switches, electronically scans 120 degrees, and operates over a 1-GHz bandwidth at X-band. The switches are an attractive alternative because of low power consumption, large ratio of off-impedance to on-impedance, extreme linearity and ability to be integrated with other devices. The 0.4 square meter antenna was built to demonstrate feasibility of much larger antennas exceeding eight square meters. Much of the enhanced antenna performance is attributed to employing MEMS switches instead of traditional semiconductor-based switching technologies. MEMS switches manufactured by Radant have a volume of only 1.5 cubic millimeters and are produced by wafer capping of a micro-electromechanical switch mechanism that travels less than 1 micrometer in 10 microseconds.

Rear view of the 0.4 m2 MEMS ESA integrated with a Lockheed APG-67 Radar System

Extremely high reliability (exceeding 1.5 trillion switch cycles) has been achieved in several DoD laboratories. The Radant MEMS switch technology derived from the DARPA SBIR, RF MEM Improvement Programs (RFMIP) and HERMIT programs is expected to have broad use as a replacement for semiconductor technology. MEMS switches, in comparison to their semiconductor counterparts, are characterized by low insertion loss, high isolation, broad bandwidths, high linearity, near zero power consumption, small size.

LESSONS LEARNED & BEST PRACTICES

- Collaborating and partnering with key commercial and government organizations to supplement the company's relatively small and focused staff was crucial to success.
- Partnerships facilitated access to technology and testing that would have been not obtainable otherwise and directly contributed to advancing the program technology.
- Government testing of MEMS switch technology provided technical validation and was invaluable in company marketing efforts by confirming the reliability of ESA and MEMS technology.
- Partnering with a prime contractor who can test and employ technology greatly improves transitioning success.

ECONOMIC IMPACT

The SBIR programs were instrumental in the development of novel antenna and MEMS switch technologies, from which Radant MEMS has launched nine commercial, off-the-shelf MEMS switch products. These switch products are currently being evaluated by military and commercial customers and Radant is actively seeking additional applications for the antenna technology. This funding was critical to growing the Lightweight and Low-Cost Electronically Steerable Antennas and MEMS switches and components business segments within Radant Technologies which will lead to increased employment as these technologies mature.

APPLICATIONS

Radant teamed with Lockheed Martin to integrate MEMS ESA into the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS) antenna risk reduction effort. JLENS is developing a sensor system suitable for aerostats and airships that improves battlefield information superiority and airspace dominance. This technology has been proposed for high-altitude airships and a persistent-threat system to detect and track multiple vehicles and dismounts during day, night, and adverse weather conditions.

MEMS switches are expected to be important building blocks for products such as phase shifters, antennas, automatic test equipment, cellular devices, instrumentation and filters. Radant developed an electrostatically actuated broadband ohmic microswitch based on a cantilever beam that is fabricated using a surface micromachining process and operates in a hermetic environment obtained through a wafer-bonding process.

PARTNERING & COLLABORATION

A partnership formed with a large semiconductor company led to the acquisition of the MEMS switch technology and the creation of Radant MEMS Inc., an affiliate that manufactures a variety of MEMS products. In another partnership, Lockheed Martin provided radar system engineering and access to Lockheed's radar assets and test ranges. MEMS switch technology has continued to improve via participation in the DARPA RFMIP and HERMIT programs. In collaboration with AFRL, Army Research Lab and Naval Research Lab, conducted extensive RF and lifetime testing on numerous Radant MEMS switches. They independently verified Radant's measured performance, employing military relevant waveforms, and were successful in achieving 1.5 trillion switch cycles. This is believed to be the longest recorded lifetimes for a MEMS ohmic switch.

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MEERCAT®: VISUAL ANALYSIS OF WIRELESS RISKS TO CRITICAL CYBER ASSETS

CONTACT INFORMATION

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Topic Name:	**MeerCAT: Visual Analysis of Wireless Risks to Critical Cyber Assets**
Topic Number:	**SB052-005**
Contract Number:	**W31P4Q-07-C-0022**
DARPA Office:	**STO (formerly ATO)**

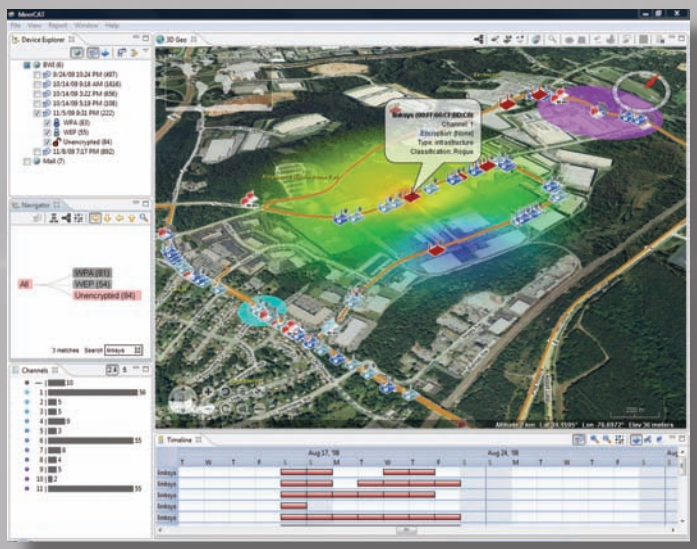
ABOUT THE COMPANY

Applied Visions, Inc.
Secure Decisions Division
Founded 1987 -
CEO and President, Frank Zinghini.
Applied Visions, Inc. (AVI) develops visual software solutions to help solve complex defense, national security, information security, infrastructure protection, financial, and business problems.

Visualization tool helps find and counter wireless threats

VALUE PROPOSITION

MeerCAT helps security teams discover, visualize, analyze and report wireless threats across distributed locations and time periods. MeerCAT presents temporal and spatial views of communication and movement patterns that indicate serious threats.



This example of MeerCAT shows 2D and 3D visualizations of wireless security threats in the vicinity of Baltimore/Washington International Airport

TECHNICAL CHALLENGE ADDRESSED

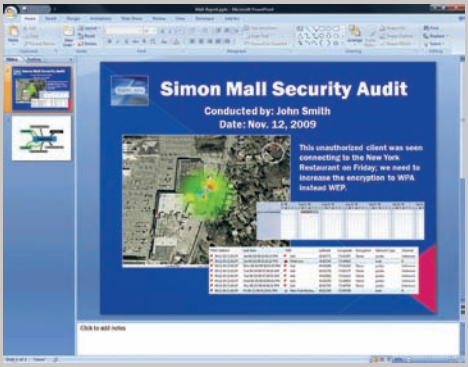
Mobile cyber assets and wireless networks present unique security challenges since wireless signals can be intercepted and unauthorized signals can be injected into networks. Tools that locate wireless activity generate massive amounts of data requiring special expertise and considerable time to correlate and interpret for threat detection. Security teams conduct wireless security audits, called "wardrives," to locate wireless emitters, but detection tools have limited capability to combine, analyze rapidly and depict collected data beyond a single time/location.

The DARPA SBIR project addressed the need for an analysis and visualization tool to correlate collections from open-source and Department of Defense (DoD) wardriving tools and wireless intrusion detection systems. The tool allows security teams to identify, evaluate, and counter suspicious, unauthorized access near networks and facilities by showing wireless device activities. This extends available wireless security methods by adding an ability to analyze large data volumes, visually depict threats by their temporal and spatial patterns, and efficiently report results.

TECHNOLOGY DESCRIPTION

MeerCAT is an integrated set of visualization tools that helps analyze risks to critical assets from mobile threats by presenting a unified picture of the location, security state, behavior patterns, temporal patterns, channel usage and mission of both authorized and unauthorized wireless devices. It provides a 3D geographic fly-through visualization showing satellite imagery and color-coded graphic views of wireless devices and their attributes and relationships. It then links these views to provide multiple, simultaneous perspectives of the data—such as before and after remediation—in an intuitive, interactive visual environment where highlighting or filtering in one view is reflected in all other views.

MeerCAT visualizes data collected from a variety of sources, including wireless discovery "wardriving" tools like Kismet, NetStumbler, and Flying Squirrel; wireless intrusion detection system sensors and communication sources like AirPcap. It may also be used with other applications needing analysis and spatial visualization to manage resources or characterize threats, including those for wired and wireless networks, intelligence teams tracking blue and red forces, mobile asset tracking and personnel security.



MeerCAT streamlines the reporting process by automatically creating PowerPoint presentations from its visualizations, using a library of user-created templates

MeerCAT is a modular system that can be extracted and incorporated into larger systems. MeerCAT can also be used as a stand-alone system interfaced to external data sources. It is implemented in Java using the Eclipse Rich Client Platform (RCP) and Standard Widget Toolkit (SWT) for cross-platform support with native look and feel.

LESSONS LEARNED & BEST PRACTICES

- Identify users early, and enlist them to describe requirements and major challenges.
- Work with government laboratories for greater exposure to users and access to the latest technology.
- Select a project name that people will remember and associate with its use.
- Use commercial scenarios for demonstrations to show benefits without revealing government locations.

ECONOMIC IMPACT

SBIR programs account for approximately 30% of the company's annual revenue. Expansion of MeerCAT supported by Phase III investments contributed to the company's 20% year-over-year growth.

The deployment of MeerCAT to DoD Flying Squirrel users helps establish MeerCAT as a commercial-quality product and facilitates its sale to commercial customers. A patent application has been submitted for MeerCAT, and the product has been cleared through the U.S. Department of Commerce for export.

APPLICATIONS

A version of MeerCAT, called MeerCAT-Flying Squirrel, is being integrated as a GOTS application with the Naval Research Laboratory-developed Flying Squirrel (FS) Wireless Discovery Tool Suite for use across the Department of Defense. In the 4th quarter of fiscal year 2010, MeerCAT will be available to more than 3,000 current DoD analysts who use Flying Squirrel to identify suspicious wireless access points in or near government facilities. DoD and intelligence community blue teams use MeerCAT to assess vulnerabilities while red teams use MeerCAT for penetration testing to locate wireless vectors.

Certified security engineers from Crimson Security, Inc. use MeerCAT during compliance audits to identify wireless networks, locate access points (APs), and analyze data flowing over those APs. Crimson's Chief Security Officer noted that MeerCAT "allows us to verify with the organization we are auditing that all wireless APs are accounted for", that an "analysis of an organization's wireless environment is also more thorough", and that this time-consuming process "has been reduced sharply with the addition of MeerCAT to the toolkit".

PARTNERING & COLLABORATION

Secure Decisions has worked closely with NRL, developers of the Flying Squirrel collection tool, and Air Force Research laboratory (AFRL) to incorporate MeerCAT into a system for detecting and tracking suspicious insiders who might be using wireless devices within government buildings. As a result, MeerCAT is able to depict the location and movement of wireless devices both outside *and* inside a building.

Several of MeerCAT's beta testers were DoD wireless security analysts experienced in collecting data with a variety of tools, but who were looking for a method of performing *post hoc* analysis of the collected data. Two large systems integrators have provided funding to customize MeerCAT.

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COMPACT ACOUSTIC-SEISMIC UNATTENDED GROUND SENSOR

SenTech

CONTACT INFORMATION

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Ph: 617-354-6644
www.sentech-acoustic.com

Topic Name:	**Low-Cost, Miniature Unattended Sensor Systems**
Topic Number:	**SB971-018**
Contract Number:	**DAAH01-98-C-R160**
DARPA Office:	**STO (formerly ATO)**

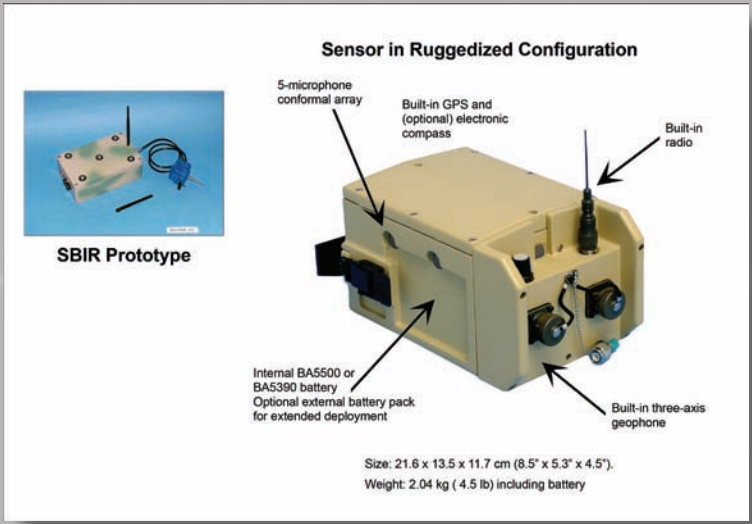
ABOUT THE COMPANY

SenTech, Inc.
Founded 1993
Dr. Gervasio Prado, CEO.
SenTech provides acoustic, seismic, and electro-optic unattended sensor solutions for a wide variety of surveillance applications and has established itself as a leader in the design of passive, unattended ground sensor systems.

Now partnering with larger defense contractors

VALUE PROPOSITION

Low cost, small, easily deployable, unattended acoustic-seismic sensors are an effective technology for covertly detecting, identifying, locating, and tracking vehicles and dismounted personnel.



Sensor design evolve from prototype to ruggedized configuration

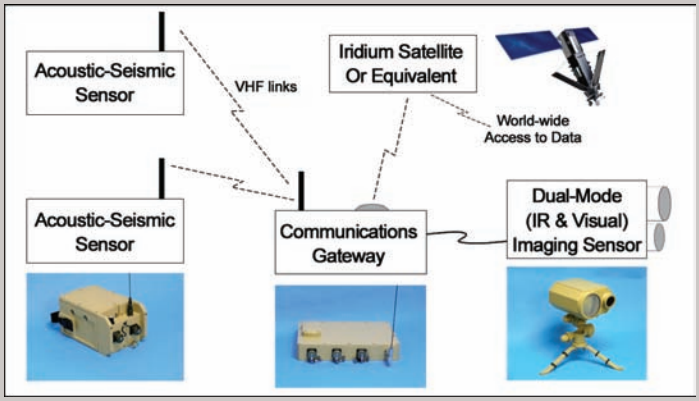
TECHNICAL CHALLENGE ADDRESSED

Under this DARPA SBIR, SenTech developed a small, low cost, five-inch-diameter acoustic-seismic sensor array that can be placed easily by hand or air-dropped by helicopter. The challenge was to develop advanced seismic processing techniques that would eliminate noise; use seismic signatures to identify passing vehicles; and also determine vehicle bearing, velocity and range. This work was successful, and these acoustic-seismic capabilities were extended and incorporated into various military platforms and applications.

This project built upon an earlier success, funded by Sandia National Laboratories, which demonstrated that unattended acoustic-seismic ground sensors were effective for covert surveillance of military vehicles. The solutions to this challenge included electronics that significantly reduced power consumption; improved algorithms for detecting, identifying, and tracking multiple vehicles in convoys; and methods for summarizing information for satellite transmission. The DARPA funding extended these achievements.

TECHNOLOGY DESCRIPTION

The compact acoustic-seismic unattended ground sensors are able to detect, track, and identify ground vehicles and dismounted personnel. An autonomous geo-location capability (global positioning system [GPS] and compass) was incorporated into the sensors to autonomously record their location, so that they could be easily emplaced without adding to the soldier's burden.



Sentech's acoustic-seismic sensors as part of a militarized sensor suite and communication system

The sensors and signal processing methods addressed several essential functions, including target localization using a small conformal microphone array, seismic detection and localization using a three-axis geophone; and target tracking and identification using an embedded digital signal processor and neural networks trained with the spectral features of the target emissions.

Knowledge-based classification algorithms identify and differentiate targets and interpret field activity based on the characteristics of vehicle acoustical noise emissions. Advanced seismic processing techniques eliminate the contribution of acoustically coupled seismic noise and determine the location of the vehicle. Seismic signature processing methods are employed to obtain target bearing, determine absolute velocity, and estimate target range.

LESSONS LEARNED & BEST PRACTICES

- Use higher levels of integration in electronics components. This allowed SenTech to provide smaller sensors with increased processing capabilities at a reasonable price.
- Develop new components, if necessary, to meet customer needs.
- Use a multi-level processing scheme to reduce overall power consumption and achieve longer deployment times.
- Balance the right level of functionality vs. cost to generate the level of demand required to set up a production line.
- Partner with larger defense contractors to achieve the level of financial backing necessary to maintain a profitable product line.

ECONOMIC IMPACT

Developing a more advanced sensor technology than competitors allowed SenTech to partner with larger defense contractors and participate in many defense programs. SenTech found that it could not acquire orders large enough to merit a full-scale production line; sensors had to be manufactured in small lots with large amounts of manual labor, thus lowering profitability.

APPLICATIONS

SenTech has successfully applied its sensor and signal processing technology developed under DARPA and Sandia National Laboratories funding for a variety of military applications. For the U.S. Army Tank-automotive and Armaments Command, the company developed an acoustic sensor to detect and track combat vehicles at extended ranges. For the U.S. Army Armament Research, Development and Engineering Center, they developed a new approach for target classification and identification that combines artificial intelligence techniques with statistical pattern recognition algorithms for high performance target classification and scenario interpretation.

SenTech supported the U.S. Navy Naval Undersea Warfare Center in two field trials involving the design and test of a planar hydrophone array used to track towed acoustic sources and targets of opportunity. Other military applications include the Acoustic Warning System, an easy-to-deploy, highly accurate sniper location system. In addition to military use, the sensors and processing methods have potential for use in border protection and drug interdiction.

PARTNERING & COLLABORATION

SenTech teamed with General Dynamics to develop the Intelligent Munitions System, a networked target-tracking and fire-control system. The companies also partnered on the Massively Deployed Unattended Ground Sensor System. Both of these systems used the main processor of SenTech's sensor.

For Harris RF Communications, the company developed a new dual mode imager (infrared [IR] and visual) and licensed the design of its acoustic-seismic sensor. The imaging sensor combines IR and visual cameras and built-in image processing capabilities in a compact militarized package.

The Acoustic Warning System was a joint development project with Lockheed Martin's Infrared and Imaging Systems. It gained high marks for accuracy during government-sponsored tests at the United States Marine Corps Camp Pendleton Military Operations.

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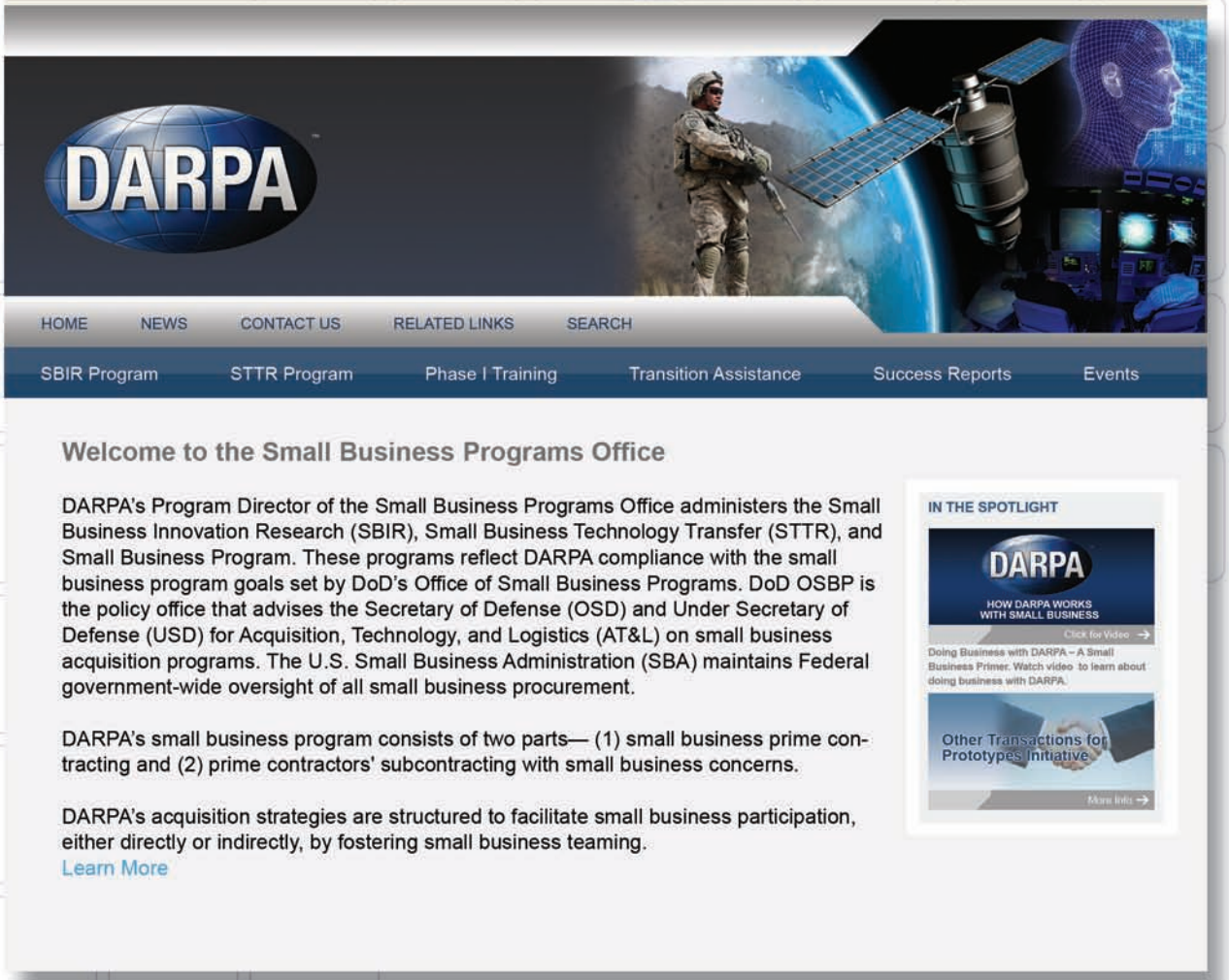
DARPA SBPO web site



For more information visit: www.darpa.mil/sbpo

2010

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