

**Office Of The Secretary Of Defense (OSD)
Deputy Director Of Defense Research & Engineering
Deputy Under Secretary Of Defense (Science & Technology)
Small Business Innovation Research (SBIR)
FY2003.2 Program Description**

Introduction

The Deputy Under Secretary of Defense (Science & Technology) SBIR Program is sponsoring three information systems technology themes in this, the second of two FY2003 solicitations: Software Producibility, Improving Spectrum Efficiency and Integration & Visualization of Uncertain Information for Situation Awareness. We are also co-sponsoring two additional technology areas, biomedical technology and information technology for military health systems, with Defense Health Affairs.

All of the services are participating in the OSD program this year. The service laboratories act as our OSD Agent in the management and execution of the contracts with small businesses. The Army, Navy and Air Force laboratories, often referred to as a DoD Component acting on behalf of the OSD, invite small business firms to submit proposals under this Small Business Innovation Research (SBIR) program solicitation. In order to participate in the OSD SBIR Program this year, all potential proposers should register on the DoD SBIR website as soon as you can, and should follow the instruction for electronic submittal of proposals. It is required that all bidders submit their proposal cover sheet, company commercialization report and their firm's technical and cost proposal form electronically through the DoD SBIR/STTR Proposal Submission Website at <http://www.dodsbir.net/submission>. If you experience problems submitting your proposal, call the help desk (toll free) at 1-866-724-7457. You must include a Company Commercialization Report as part of each proposal you submit; however, it does not count against the proposal page limit. Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal. The DoD SBIR Proposal Submission Website allows your company to come in any time (prior to the proposal submission deadline) to edit your Cover Sheets, Technical and Cost Proposal and Company Commercialization Report.

We WILL NOT accept any proposals that are not submitted through the on-line submission site. The submission site does not limit the overall file size for each electronic proposal, there is only a page limit. However, file uploads may take a great deal of time depending on your file size and your internet server connection speed. If you wish to upload a very large file, it is highly recommended that you submit prior to the deadline submittal date, as the last day is heavily trafficked. You are responsible for performing a virus check on each technical proposal file to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. We will not accept e-mail submissions.

Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, the DUSD(S&T) SBIR Program will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector. Objectives of the DUSD(S&T) SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results. The guidelines presented in the solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

The topics are presented in two technology areas: Information Systems and Defense Health Biomedical/ Information Management. The topic descriptions, that follow this program overview section, are listed below.

The Information Systems Technology Topics follow this section and are:

- OSD03-021 Modernization of Legacy Software: Re-engineering Low-Level Code (OSD/Navy)
- OSD03-022 High Performance Object Oriented Software for Parallel Embedded Systems (OSD/AF)
- OSD03-023 Error Handling Techniques for Robust Mission Critical Software (OSD/Navy)
- OSD03-024 Radar Wireless Spectral Efficiency (OSD/Navy)
- OSD03-025 Fast, Flexible, Adaptive Channel Coding with Near-Shannon-Limit Performance (OSD/AF)
- OSD03-026 Beyond Spectrum: Multiobjective Joint Optimization for Efficient Utilization of the Radio Frequency Transmission Hypercube (OSD/AF)
- OSD03-027 Information Fusion System for Counter-Terrorism Operations (OSD/Navy)
- OSD03-028 Information Uncertainty Portrayal (OSD/AF)
- OSD03-029 Portraying Uncertainty in Battlefield Weather Situational Awareness (OSD/Army)
- OSD03-030 Leadership Agent for Multi-source Information Fusion in Counter-Terrorism (OSD/Army)

The Defense Health Biomedical/Information Management Technology Topics follow this section and are:

- OSD03-DH01 Optimized Off-the-shelf Portable Trap for Haematophagous Arthropods (OSD/DHP)
- OSD03-DH02 Biological Effects Pattern Recognition Tool Using Multivariate Statistical Data Reduction (OSD/DHP)
- OSD03-DH03 Advanced Force Protection Tools (AFPROT) for Integrated Mission Planning (OSD/DHP)
- OSD03-DH04 Deployable Simulation Training for Operational Medical Personnel & Emergency Responders (OSD/DHP)
- OSD03-DH05 Training Military Medical Personnel for Respond for Directed Energy Weapons and Technology Casualties on Humanitarian Missions (OSD/DHP)
- OSD03-DH06 Predicting Cognitive Performance of Deploying Health Teams (OSD/DHP)
- OSD03-DH07 Distributed Medical Training for Force Mobilization and Disaster Response (OSD/DHP)
- OSD03-DH08 Facilitating Post-Deployment Data Mining to Evaluate War-Related "Medically Unexplained Symptoms" by Means of Required Structured Data Entry (OSD/DHP)
- OSD03-DH09 Development of Wireless Electronic Information Carrier (OSD/DHP)
- OSD03-DH10 Data Mining Longitudinal Clinical Data to Detect Adverse Drug Events (OSD/DHP)

Description of the OSD SBIR Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months, with a dollar value up to \$100,000. We plan to fund 3 Phase I contracts, on average, and downselect to one Phase II contract per topic. This is assuming that the proposals are sufficient in quality to fund this many. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable prototype or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the DoD may award non-SBIR funded follow-on contracts for products or processes, which meet the component mission needs. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The small business is expected to use non-federal capital to pursue private sector applications of the research and development.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be invited to submit a Phase II proposal. DoD is not obligated to make any awards under Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract. For specifics regarding the evaluation and award of Phase I or II contracts, please read the front section of this solicitation very carefully. Every Phase II proposal will be reviewed for overall merit based upon the criteria in section 4.3 of this solicitation, repeated below:

- a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
- b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.
- c. The potential for commercial (defense and private sector) application and the benefits expected to accrue from this commercialization.

In addition, the OSD SBIR Program has a *Phase II Plus* Program, which provides matching SBIR funds to expand an existing Phase II that attracts investment funds from a DoD acquisition program. Private sector investments will also be considered for *Phase II Plus* funding. *Phase II Plus* allows for an existing Phase II OSD SBIR effort to be extended for up to one year to perform additional research and development. *Phase II Plus* matching funds will be provided on a one-for-one basis up to a maximum \$250,000 of SBIR funds. All *Phase II Plus* awards are subject to acceptance, review, and selection of candidate projects, are subject to availability of funding, and successful negotiation and award of a *Phase II Plus* contract modification.

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed the technical thresholds and have met their Phase I technical goals, as discussed Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract (see the Fast Track Application Form on www.dodsbir.net/submission). Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company. For projects that qualify for the Fast Track (as discussed in Section 4.5), DoD will evaluate the Phase II proposals in an expedited manner in accordance with the above criteria, and may select these proposals for Phase II award provided: (1) they meet or exceed selection criteria (a) and (b) above and (2) the project has substantially met its Phase I technical goals (and assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Fast Track proposals, having attracted matching cash from an outside investor, presumptively meet criterion (c). However, selection and award of a Fast Track proposal is not mandated and DoD retains the discretion not to select or fund any Fast Track proposal.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that

the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General informational questions pertaining to proposal instructions contained in this solicitation should be directed to the topic authors and point of contact identified in the topic description section. Oral communications with DoD personnel regarding the technical content of this solicitation during the pre-solicitation phase are allowed, however, proposal evaluation is conducted only on the written submittal. Oral communications during the pre-solicitation period should be considered informal, and will not be factored into the selection for award of contracts. Oral communications subsequent to the pre-solicitation period, during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness. Refer to the front section of the solicitation for the exact dates.

Proposal Submission

Proposals shall be submitted in response to a specific topic identified in the following topic description sections. The topics listed are the only topics for which proposals will be accepted. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

It is required that all bidders submit their proposal cover sheet, company commercialization report and their firm's technical and cost proposal form electronically through the DoD SBIR/STTR Proposal Submission Website at <http://www.dodsbir.net/submission>. If you experience problems submitting your proposal, call the help desk (toll free) at 866-724-7457. You must include a Company Commercialization Report as part of each proposal you submit; however, it does not count against the proposal page limit. Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal. The proposal submission website allows your company to come in any time (prior to the proposal submission deadline) to edit your Cover Sheets, Technical and Cost Proposal and Company Commercialization Report. We **WILL NOT accept any proposals which are not submitted through the on-line submission site.** The submission site does not limit the overall file size for each electronic proposal, only the number of pages are limited. However, file uploads may take a great deal of time depending on your file size and your internet server connection speed. You are responsible for performing a virus check on each technical proposal file to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. We will not accept e-mail submissions.

The following pages contain a summary of the technology areas, which are followed by the topics.

**Office Of The Secretary Of Defense (OSD)
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Deputy Under Secretary Of Defense (Science & Technology)
Information Systems Technology Area**

The Information Systems Technology area is comprised of nine topics, three in each of the following technology themes:

I. SOFTWARE PRODUCIBILITY TECHNOLOGY THEME

DoD's inability to produce complex mission-critical software systems affordably, predictably, and with the required robustness continues to plague the national security community. Equally challenging is the need to calibrate trust or confidence in a system - the certification or assessment of how well a given software product meets a range of complex constraints and goals. Recent studies indicate that the majority of large, complex software systems attempted by the DoD never reach deployment as originally intended. Costs go up dramatically, functionality is substantially reduced or delayed, or the systems are cancelled outright. Despite some advances over the past decade in design and construction of complex software systems, these improvements have not kept pace with the substantial increases in software requirements for national security systems. "Our reach exceeds our grasp" and our reach is increasing. To address these concerns, this SBIR area solicits proposals for software engineering tools, techniques, and algorithms to effectively and efficiently produce mission critical software systems to support Warfighter requirements. Potential topics include modernization of legacy software by re-engineering code, formal methods for verification, composability of COTS components, and efficient yet high-coverage testing techniques.

The three Software Producibility Technology Topics are on the pages to follow and are:

- OSD03-021 Modernization of Legacy Software: Re-engineering Low-Level Code (ONR)
- OSD03-022 High Performance Object Oriented Software for Parallel Embedded Systems (AFRL)
- OSD03-023 Error Handling Techniques for Robust Mission Critical Software (ONR)

II. IMPROVING SPECTRUM EFFICIENCY TECHNOLOGY THEME

The recent Defense Science Board Task Force on Wideband RF Modulation, Dynamic Access to Mobile Networks, contained two preliminary findings which concluded that 1) advanced communication techniques coordinating space, time, frequency, and modulation can increase spectrum utilization and that 2) potential interference among military and domestic systems and international treaties challenge the use of wideband RF modulation in systems designed with limited link margins, such as radars, signal interception, satellite, and radio astronomy. Phase I efforts under this theme will produce techniques for improving spectrum efficiency utilizing flexible and adaptive communications technologies. Potential approaches include extending the agile radio concept (i.e., the Joint Tactical Radio System (JTRS) "software programmable radio") into a wider set of capabilities, e.g. dynamic spectrum management in conjunction with commercial sector. Other potential topics include Wavelet Packet Modulation, Circular Simplex Block Coded Modulation (CSBCM), and Time-Frequency Distributions for Interference Excision in Spread Spectrum Communication

The three Improving Spectrum Efficiency Technology Topics are on the pages to follow and are:

- OSD03-024 Radar Wireless Spectral Efficiency (ONR)
- OSD03-025 Fast, Flexible, Adaptive Channel Coding with Near-Shannon-Limit Performance (AFRL)
- OSD03-026 Beyond Spectrum: Multiobjective Joint Optimization for Efficient Utilization of the Radio Frequency Transmission Hypercube (AFRL)

III. INTEGRATION & visualization of uncertain information for situation awareness theme

The modern battlespace is a complex, rapidly changing, uncertain environment. With every event in a battlespace, there is an associated uncertainty. The uncertainty of an event or combination of events changes with time. In addition, the uncertainty of potentially important events is not assessed in isolation. Instead, uncertainty is judged in relation to other events happening at the same time in the same location as well as events happening at the same time at other locations. Making decisions requires a model of the battlespace that incorporates uncertainty. Current techniques that integrate information do not usually provide commanders with information concerning uncertainty. Novel techniques that integrate information from multiple sources, and properly account for uncertainty of information are required. Potential topics include visualization of network data for situational awareness, conformable image presentation systems, visualization of battlefield weather, intelligent software agents for uncertainty management and visualization, and multi-source information fusion for counter-terrorism operations.

The three Integration & Visualization Of Uncertain Information For Situation Awareness Technology Topics are on the pages to follow and are:

- OSD03-027 Information Fusion System for Counter-Terrorism Operations (ONR)
- OSD03-028 Information Uncertainty Portrayal (WPAFB)
- OSD03-029 Portraying Uncertainty in Battlefield Weather Situational Awareness (ARL)
- OSD03-030 Leadership Agent for Multi-source Information Fusion in Counter-Terrorism

Office Of The Secretary Of Defense (OSD)
Deputy Director Of Defense Research & Engineering
Deputy Under Secretary Of Defense (Science & Technology)/Defense Health Program
Biomedical & Information Management Information Technology Focus Area

The Department of Defense is aggressively pursuing unified Force Health Protection strategies to protect Service members and their family members from health hazards associated with military service. Toward that end, DoD is undertaking strategies that promote healthy units and communities while improving both force morale and war fighting capabilities.

The operational force is exposed to health threats throughout the operational continuum, from CONUS fixed facilities (garrison, base, ashore) through deployment, employment, and redeployment. DoD is developing policy and procedures to assess occupational and environmental health threats for all locations. A comprehensive record of current health-and of past health events and resultant exposure levels-will be maintained for as many as 100,000 U.S. military personnel over their entire military-service cycle (the Millennium Cohort Study).

When Force Health Protection capabilities are fully implemented, commanders will have a more complete view of potential health threats. Integration of assessments from health databases and other assessments from intelligence (e.g., about land mines, directed enemy fire, fratricide) and safety (e.g., about injuries, vehicle accidents, explosives, aviation mishaps) will provide a framework for identifying future medical technology capabilities necessary for Force Health Protection.

Ensuring the health of the force encompasses several key capabilities:

- To provide FDA-approved prevention, diagnosis and treatment items for disease and injury;
- To mobilize, deploy and sustain field medical services and support for any operation requiring military services;
- To maintain and project the continuum of healthcare resources required to provide for the health of the force;
- To operate in conjunction with beneficiary healthcare; and
- To develop training systems which provide realistic rehearsal of emergency medical and surgical procedures and unit-level medical operations.

These capabilities comprise an integrated and focused approach to protect and sustain DoD's most important resource-its Service members and their families-throughout the entire length of service commitment. Three broad capability areas of particular interest are tools and techniques for risk communication, for epidemiology research, and for delivery of health education and training unique to DoD functions. These are described in more detail below:

Health Risk Assessment and Communication Decision Tools: Risk analysis is a science-based process that strives to reflect the realities of nature as accurately as possible. The Department experienced significant challenges in determining and communicating risk on illnesses among Gulf War veterans, such as that for the anthrax vaccination program, as well as other deployments. A decision support tool is needed that produces a likelihood index of risk based on epidemiological, intelligence, environmental exposure, and health information concerning deployed forces.

New Methods to Monitor Health Status: Monitoring of health status during deployments is necessary to determine etiologic factors of deployment related health change. Health monitoring should be for a sharply limited set of physiologically based indicators, and should yield an unambiguous interpretation of health status.

Force Health Distributed Learning Tools: Developing and maintaining diagnostic and treatment skills among military physicians-as well as lifesaving buddy- and self-aid skills among other military personnel and laymen-are important aspects of first-response capabilities. Advanced distributed learning and other computer-based training technology should enable all responders to assist in providing health care in emergency situations involving chemical, biological, radiological, and nuclear events as well as traumatic injury, and should assist medical professionals to maintain clinical knowledge and skills.

Information Management Information Systems: The Military Health System has approximately 80 major Military Treatment Facilities, 500 clinics, 160,000 healthcare personnel, and 8.3 eligible beneficiaries. This results in approximately 900,000 outpatient visits and 10, 000 admissions per week. The objective of the topics in the area

of information technology, is to develop an information management system to support the Military Health System in the areas of: 1) access to care, 2) provision of care, 3) managing the business, and population health management.

We have chosen the following topics and Service Laboratory Executive Agents to manage the SBIR topics in this technology area:

- OSD03-DH01 Optimized Off-the-shelf Portable Trap for Haematophagous Arthropods (MRMC)
- OSD03-DH02 Biological Effects Pattern Recognition Tool Using Multivariate Statistical Data Reduction (WPAFB)
- OSD03-DH03 Advanced Force Protection Tools (AFPROT) for Integrated Mission Planning (WPAFB)
- OSD03-DH04 Deployable Simulation Training for Operational Medical Personnel & Emergency Responders (WAFB)
- OSD03-DH05 Training Military Medical Personnel for Respond for Directed Energy Weapons and Technology Casualties on Humanitarian Missions (BAFB)
- OSD03-DH06 Predicting Cognitive Performance of Deploying Health Teams (WAFB)
- OSD03-DH07 Distributed Medical Training for Force Mobilization and Disaster Response (ONR)
- OSD03-DH08 Facilitating Post-Deployment Data Mining to Evaluate War-Related "Medically Unexplained Symptoms" by Means of Required Structured Data Entry (TATRC)
- OSD03-DH09 Development of Wireless Electronic Information Carrier (TATRC)
- OSD03-DH10 Data Mining Longitudinal Clinical Data to Detect Adverse Drug Events (TATRC)

03.2 Topic List

- OSD03-021 Modernization of Legacy Software: Re-engineering Low-Level Code
- OSD03-022 High Performance Object Oriented Software for Parallel Embedded Systems
- OSD03-023 Error Handling Techniques for Robust Mission Critical Software
- OSD03-024 Radar Wireless Spectral Efficiency
- OSD03-025 Fast, Flexible, Adaptive Channel Coding with Near-Shannon-Limit Performance
- OSD03-026 BEYOND SPECTRUM: Multiobjective Joint Optimization for Efficient Utilization of the Radio Frequency Transmission Hypercube
- OSD03-027 Information Fusion System for Counter-Terrorism Operations
- OSD03-028 Information Uncertainty Portrayal
- OSD03-029 Portraying Uncertainty in Battlefield Weather Situational Awareness
- OSD03-030 Leadership Agent for Multi-source Information Fusion in Counter-Terrorism
- OSD03-DH01 Optimized Off-the-shelf Portable Trap for Haematophagous Arthropods
- OSD03-DH02 Biological Effects Pattern Recognition Tool Using Multivariate Statistical Data Reduction
- OSD03-DH03 Advanced Force Protection Tools (AFPROT) for Integrated Mission Planning
- OSD03-DH04 Deployable Simulation Training for Operational Medical Personnel & Emergency Responders
- OSD03-DH05 Training Military Medical Personnel for Respond for Directed Energy Weapons and Technology Casualties on Humanitarian Missions

- OSD03-DH06 Predicting Cognitive Performance of Deploying Health Teams
- OSD03-DH07 Distributed Medical Training for Force Mobilization and Disaster Response
- OSD03-DH08 Facilitating Post-Deployment Data Mining to Evaluate War-Related "Medically Unexplained Symptoms" by Means of Required Structured Data Entry
- OSD03-DH09 Development of Wireless Electronic Information Carrier
- OSD03-DH10 Data Mining Longitudinal Clinical Data to Detect Adverse Drug Events

OSD 03.2 Topic Descriptions

OSD03-021 TITLE: Modernization of Legacy Software: Re-engineering Low-Level Code

TECHNOLOGY AREAS: Information Systems

TITLE: Modernization of Legacy Software: Re-engineering Low-Level Code

DoD CRITICAL TECHNOLOGY: Software Producibility

OBJECTIVE: Develop software tools to facilitate re-engineering and re-hosting legacy code.

DESCRIPTION: The modernization of legacy weapons systems can require upgrading software written in obsolete programming languages for obsolete hardware platforms running on obsolete operating systems in order to extend the useful life of a military asset. Emulation techniques have a significant drawback because the software is retained and must be maintained in its original obsolete form. An alternative is translation technology, which would convert legacy software from a low-level language such as assembler or CMS-2 to a modern high-level programming or specification language. Key characteristics of such translations include demonstrable correctness wherein a translation preserves semantics despite changes in the operating environment, practical maintainability whereby generated source code meets guidelines for quality and style, effective re-targetability that facilitates adaptation to new low-level input languages.

The technical risks are considerable. The underpinning assumptions in code must be made explicit and shown compatible with those of the new environment. Often, these assumptions shape the code but are non-functional in nature and difficult to extract. Moreover, the cost of re-certifying is significant and could be nearly the same as for a new system if one is not careful. Building on straight-forward strictly syntactic transformations is often insufficient and yields poor results. In short, innovative reliable ways are needed to re-use legacy programs in newer environments that significantly reduce overall re-development effort, amortize the original cost of development, and facilitate software upgrade, adaptation, and understanding.

PHASE I: Develop the technological basis for new translation techniques that scale with respect to size, heterogeneity and real-time schedulability, and that increase understandability, visibility and assurance in the overall processes of adapting and deploying software correctly. Design a research prototype that embodies these principles, and with sufficient detail to enable a thorough assessment of a proposed design.

PHASE II: Build the proposed research prototype, assess its capabilities and limitations, and compare its relevant functionality to currently available technologies. Demonstrate and evaluate the feasibility and affordability of the technology.

PHASE III DUAL-USE COMMERCIALIZATION: DoD acquisition has been affected by the high cost and labor of re-hosting software, e.g., on military aircraft whose effective service life covers decades, yet whose information technology must be updated and upgraded comparatively frequently. Even with the limited translation technology available today, the cost of software migration is enormous; for example, an avionics refresh may cost hundreds of millions of dollars. Industry is similarly affected with regard to their software intensive systems that are long-lived. Commercial opportunities also exist, including the refresh of industrial applications. This technology, if successful, would make adapting, certifying, and re-hosting software affordable and practical and would enable the useful life of software-intensive systems to be extended.

REFERENCES:

1. Lt. Col. Glenn A. Palmer, "Software Community: Ready for the Challenges of Avionics Upgrade?", Crosstalk, September, 2001, <http://www.stsc.hill.af.mil/crosstalk/2001/09/publisher.html>
2. A. Porter and J. Sztipanovits (editors), Workshop Report on New Visions for Software Design & Productivity: Research & Applications, Vanderbilt University (December 2001). http://www.hpcc.gov/iwg/sdp/vanderbilt/report/sdp_workshop_20020726.pdf

3. Cristina Cifuentes, Doug Simon, Antoine Fraboulet, "Assembly to High-Level Language Translation." Dept. of CS and EE, The University of Queensland, Australia, 1998. URL: www.itee.uq.edu.au/~cristina/icsm98.ps

KEYWORDS: software producibility, certification, correctness-by-construction, decompilation, real-time schedulability, reverse engineering

OSD03-022 TITLE: High Performance Object Oriented Software for Parallel Embedded Systems

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: To conduct research into developing technologies that drastically reduce the performance penalties associated with deploying object oriented software on high performance parallel embedded systems.

DESCRIPTION: Over the past three decades, the Department of Defense (DoD) has made significant investments in sensor systems that employ high performance embedded computing (HPEC) to do Signal and Image Processing (SIP) for critical national challenges in the areas of Intelligence, Surveillance, and Reconnaissance (ISR). The dominant cost of these systems is the development and maintenance of highly tuned and specialized software required to fully utilize HPEC hardware.

In Feb 2001, the DoD established the High Performance Embedded Computing Software Initiative (HPEC-SI) to develop new software standards to decrease the cost and increase the reuse of software developed for HPEC systems. Critical to this effort is the exploitation of modern object oriented languages (e.g. C++) which have consistently reduced the development time of software projects in many domains. To exploit these benefits HPEC-SI is currently funding the definition of C++ and parallel computing extensions to the Vector, Signal, and Image Processing Library (VSIPL) standard.

Object oriented technology reduces software cost by allowing programmers to work at a higher level of abstraction and thus reducing the number of lines of code that need to be written. Fully utilizing HPEC systems for SIP applications requires managing memory and computing operations at the lowest possible level. There is great concern that these two approaches may be fundamentally at odds. An expensive and impractical solution is to "hand" tune every operation (and combination of operations) in the VSIPL standard. HPEC-SI requires tools and methodologies for providing VSIPL technology that does the following: optimizes performance of high level C++ VSIPL expressions on standard HPEC processors (e.g., Motorola, MIPS, Intel, etc.); minimizes parallel performance degradation of the application software; provides robust solutions across a range of parameters; and automated to reduce implementation cost.

PHASE I: The proposal for Phase I will consist of:

1. Researching various object oriented optimization techniques and identifying the strengths and weaknesses of each technique
2. Identifying innovative tools and methodologies that are optimized, as discussed above, for deploying high performance object oriented software on HPEC systems
3. Recommendations as to what set of tools and methodologies would optimize most or all of the functions in the VSIPL standard
4. Recommendations on approaches to incorporate performance predictive capabilities into VSIPL standard and library

PHASE II: Phase II would consist of:

1. Developing prototypes of one or more of the most promising tools, methodologies, and predictive capabilities identified in Phase I

2. Developing a “test bed” for testing various SIP applications for the purpose of measuring performance benchmarks
3. Demonstrating prototype(s) using the “test bed” as a proof of concept
4. Develop a business plan presenting the case for high-probability of the successful commercialization of the "products" to be developed

PHASE III DUAL-USE COMMERCIALIZATION: Development of tools and methodologies for the high performance object oriented software would be highly marketable in both the DoD and commercial sectors. Any computer application where performance is a concern would benefit from this technology. This technology would also be applicable to any object oriented software already in widespread use (DoD or Commercial) where higher performance is desired for newer versions.

REFERENCES:

1. VSIPL: Vector, Signal, Image Processing Library <http://www.vsipl.org/>
2. HPEC-SI: High Performance Embedded Computing Software Initiative <http://www.hpec-si.org/>
3. D. Campbell and M. Richards, Object Oriented Extensions to the Vector, Signal and Image Processing Library (VSIPL) standard, DoD HPCMO Signal/Image Processing Forum (SIP 2002/GOMAC 2002), Mar 13, 2002, Monterey, CA
4. Edward Rutledge. C++ Expression Templates in an Embedded, Parallel, Real-Time Signal Processing Library. Proceedings of the Fourth Annual High-Performance Embedded Computing (HPEC) Workshop. Lexington, MA, September 2000.
5. R. Whaley and J. Dongarra. Automatically Tuned Linear Algebra Software. LAPACK Working Note 131. Technical Report UT CS-97-366, University of Tennessee, 1997.
6. Scott Haney and James Crotinger. How Templates Enable High-Performance Scientific Computing in C++. IEEE Computing in Science and Engineering, 1(4):66-72, July-Aug. 1999
7. Matteo Frigo and Steven G. Johnson. FFTW: An Adaptive Software Architecture for the FFT. Proceedings of the 1998 IEEE International Conference on Acoustics, Speech, and Signal Processing, Volume 3, pp.1381-1384. IEEE Signal Processing Society, May 1998
8. Julian C. Cummings, James A. Crotinger, Scott W. Haney, William F. Humphrey, Steve R. Karmesin, John V.W. Reynders, Stephen A. Smith and Timothy J. Williams. Rapid Application Development and Enhanced Code Interoperability using the POOMA Framework, SIAM Workshop on Object-Oriented Methods and Code Interoperability in Scientific and Engineering Computing: 0098, 1998.

KEYWORDS: High Performance, Object Oriented, Embedded, Software, Expression Templates

OSD03-023

TITLE: Error Handling Techniques for Robust Mission Critical Software

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Tools and notations to extract and reason about error handling models in large-scale software systems.

DESCRIPTION: Software is increasingly used in DoD critical applications that are exceptionally challenging in complexity, scale, and consequences of failure. Error handling is that portion of an application dedicated to detecting, handling, and reporting errors. Post-mortem analyses of a wide range of software system failures often identify a problem in error handling design or implementation as a key contributor to the failure¹. Designing and implementing robust error handling in complex software systems will always present substantial challenges; no one remedy or “silver bullet” can address all of them. However, if advances can be made in notations, tools, and techniques to make significant gains in the quality of software error handling, this would make a direct contribution to the robustness of DoD software systems. Concentration on the nominal or fault-free case has been identified as a major source of software rework costs in an analysis of complex software systems². Inadequate models, notations, tools, and underlying theory regarding software error handling in critical systems seems very likely to be a key contributor to the widespread fragility of software as noted the President's Information Technology Advisory Committee. Despite this, few software analysis and design methods explicitly address error-handling issues.

PHASE I: Design a notation and supporting tool set for representing and validating the error handling aspects of large-scale complex software systems.

PHASE II: Build research prototypes to demonstrate the use of the notation and tools. The prototypes must demonstrate the ability to represent key properties of the error handling model for large complex software systems, and to detect realistic problems in the design or implementation of error handling in these systems. These demonstrations must show meaningful improvements in the robustness of the software as a result of the application of the products of this research. The tools and notations demonstrated should accommodate programs in at least one widely use language such as Java, C, or C++.

PHASE III DUAL-USE COMMERCIALIZATION: DoD acquisition has been affected by high cost, schedule impact, and operational risk due to fragility in software intensive systems of systems. Much of this fragility is due to inadequate tools and technical foundations for rigorously constructing software error handling. Industry is also encountering affordability and predictability problems due in part to fragile software. If the results of this research are demonstrated to be useful for composing complex large scale software systems, there would be an Industry market for such solutions as well as military utility. Phase III should demonstrate a transition to market based development and containment of these capabilities for broader use.

REFERENCES:

1. "Building Dependable Systems: The Power of Negative Thinking", tutorial given at 2002 International Conference on Dependable Systems & Networks, IEEE Computer Society.
2. Boehm B, Tutorial: Software Risk Management, Washington, DC, IEEE Computer Society Press

KEYWORDS: Software producibility, error handling, robust software

OSD03-024 TITLE: Radar Wireless Spectral Efficiency

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective of this SBIR is to identify methodologies and technologies that have the potential to enable spectral co-existence between military radars and commercial wireless systems.

DESCRIPTION: This initiative seeks to understand the implications of radar spectrum loss and co-sharing with military and commercial communication systems. Future advances in commercial wireless technology are anticipated to place pressure on allocated DoD radar and communications spectrum. Technological solutions may encompass a broad range of options including, but not limited to:

- New waveform designs, for both radar and communications, which facilitate the sharing of radar and communications within the same frequency segment with minimum impact to functionality of either system.
- New hardware approaches, for radar systems that allow for spectral purity, angle-frequency spectral management, or listen before transmit approaches.
- Utilization of one or more spatial degrees of freedom (frequency, time, polarization, etc.) to facilitate the simultaneous operation of radar and communications within a spectral segment;
- Simultaneous functional adaptivity to the physical constraints for both the radar and communications system, without loss of performance, for example optimizing the following operational characteristics:
 - o The radar must -- facilitate operation in all weather, with varied environmental conditions, against a variety of target signatures and dynamics. Additionally, the radar must consider the host platform constraints like size, weight, and volume, along with, mission requirements such as; detection performance, resolution, track accuracy, and immunity to countermeasures.
 - o The communications system must - facilitate operation with propagation, latency, host platform constraints, and throughput.

In addition to these technological approaches, regulatory means within DoD and possibly the larger community, may be proposed. For example, a means for world wide spectral allocation adaptivity and regulatory management

structures to allow swapping and sharing of DoD spectrum to accommodate multiple conflicting radar and communications needs.

PHASE I: Analysis and study of proposed technological and regulatory approaches to the sharing of RF spectrum between DoD radars and commercial wireless systems. Phase I studies will develop, evaluate and quantify the merits of new concepts for: adaptive waveform generation and control; spectral and aperture resource management; automatically sensing and adapting system operating characteristics and functionality to changes in the operating environment. These phase I studies will quantify predicted performance of proposed technology and concepts. The level of effort for phase I awards will be one person year or less per award.

PHASE II: Phase II considerations will be based on predicted performance merits of Phase I. These efforts are expected to take a Phase I concept into a bread board level demonstration. The level of effort expected for phase II efforts will be up to three person years per award.

PHASE III DUAL-USE COMMERCIALIZATION: Phase III considerations will be based on the successful outcome of Phase I & II efforts, in particular performance findings from Phase II. The Phase III levels of effort are to be determined.

REFERENCES: None

KEYWORDS: radar, communications, electromagnetic spectrum, electromagnetic compatibility, shared spectrum, radio frequency interference, modulation

OSD03-025 TITLE: Fast, Flexible, Adaptive Channel Coding with Near-Shannon-Limit Performance

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop novel approaches to channel coding that take into account, and help alleviate, current issues of RF spectrum management. Truly novel concepts will also demonstrate potential for enabling spectrum management paradigm changes that revolutionize how RF users think about the transmission space in its entirety.

DESCRIPTION: About ten years ago turbo codes were publicly revealed as a method to achieve near-shannon-limit forward error correction over additive white Gaussian noise channels. Since that time significant fundamental research has been performed to expand the understanding of the “turbo” principle (interleaving and permutation). However, turbo codes still suffer from lack of dynamic adaptivity, complex decoding algorithms, and limited encoding methodologies for block-oriented systems.

Often it is necessary to deploy communication systems with sufficient agility of coding parameters to allow optimization according to channel characteristics, quality of service, latency requirements, available frequency bands, etc. In this context, coding methodologies with “turbo” performance that also exhibit fast decoding capabilities and flexible/adaptive parameter sets (on the fly) are desired.

PHASE I: 1) Conceptualize and design an novel channel coding methodology which will positively impact RF transmission space utilization, keeping in mind that the frequency dimension is only one of several that form the basis of the space. I.e., the proposed method should allow for dynamic tradeoffs between time duration (data block size), bandwidth (frequency range requirements), spatial directionality (capitalizing on multiple transmit and/or multiple receive antennas), and underlying spread spectrum spreading codes (coding/processing gain). The ideal proposal would involve a code that considers all these orthogonalizing dimensions in one unifying scheme. 2) Perform analysis, modeling and simulation for proof of concept. 3) In addition to the deliverables required by the SBIR program, other required phase I deliverables will include all code, software and documentation developed for the project.

PHASE II: 1) Develop a thorough experimentation regimen satisfactory to the DoD technical point of contact. 2) Implement the phase I algorithm in hardware with the desired experimentation plan in mind, while simultaneously

maintaining fidelity to a fieldable commercialization path. That is, the experimental hardware should be designed such that future reduction to a fielded system require minimal effort. 2) Verify performance results claimed in phase I in hardware by experiment.

PHASE III DUAL-USE COMMERCIALIZATION: Channel coding is important for both military and commercial digital communications applications. It is expected that several commercialization and militarization options would be available and identified for phase III execution.

REFERENCES: N/A

KEYWORDS: spectrum management, channel coding, electromagnetic, transmission, radio frequency, multi-dimensional, hypercube, Shannon-limit.

OSD03-026 TITLE: BEYOND SPECTRUM: Multiobjective Joint Optimization for Efficient Utilization of the Radio Frequency Transmission Hypercube

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop innovative concepts for the effective and efficient joint utilization of all orthogonal electromagnetic transmission resources, including, but not limited to, time, frequency, geographic space, modulation/code, and polarization. This multi-dimensional environment is hereafter referred to as the Transmission Hypercube (TH).

DESCRIPTION: Electromagnetic propagation at radio frequencies is currently governed by a one-dimensional “real estate” approach to allocation of frequency bands, where the licensee has specific legal right to transmit within a band. The entire spectrum from 3kHz to 30GHz is currently allocated in this fashion. Unfortunately, this “set-it-and-forget-it” management scheme is straining under the immense pressure of exponentially increasing demand by burgeoning numbers of various types of wireless devices, spanning commercial and military applications all the way from short range home networks and cordless phones to the global information grid. Given the finite nature of the RF frequency spectrum and the fact that it is fully allocated, it is desired that alternative approaches to management of the resource be developed.

The “Transmission Hypercube” is a term intended to convey the notion of a multi-dimensional resource space in which each dimension allows orthogonality amongst users. Time slicing, frequency division multiplexing, directional antenna arrays, spread spectrum codes, and polarization all independently allow for multiple users to exist without interference. A time-division multiple access scheme allots to N users a separate time slot in a time block and the users confine their respective transmissions to their allocated time slot. In this way, no two users are transmitting at the same time, even though they may be using the same frequency in the same space with the same exact spread spectrum code. Similarly, a spatially orthogonalized system allows separate users to transmit beam patterns in specific directions that do not overlap. The result is that all users can transmit at the same time, in the same frequency bands, with the same codes, but avoid interference because their transmissions do not overlap in space.

This same orthogonalization concept applies to frequency and code as well. It even applies to polarization since an antenna with vertical polarization will transmit a signal that does not interfere with another signal from an identical antenna in horizontal polarization mode. This latter example, however, will mostly apply in the context of radar systems, since multiple reflections tend to alter the polarization of the transmitted signal and therefore remove any guarantee of a known polarization at the receiver in a communications context.

Thus, there are multiple “dimensions” available in the radio frequency transmission “space” and since these dimensions number greater than three, the term Hypercube is invoked. In the Transmission Hypercube, the above-mentioned five dimensions comprise the initial basis for the space, though it is not unlikely that other dimensions (RF resources) will avail themselves as the study progresses.

Currently there are no known technological approaches to RF transmission that consider all five of these dimensions jointly, and certainly none that consider them in the context of a system optimization problem. It is the intention of this research project to develop approaches that consider the multi-dimensional nature of the transmission space (frequency, time, geographic space, modulation/code, polarization, etc.) the results of which are expected to garner several orders of magnitude improvement in RF resource utilization and therefore aggregate information throughput.

PHASE I: 1) Identify (brainstorm) every conceivable approach to a system for joint optimization of the multiple orthogonalizing transmission parameters. These approaches should include existing policies and ideas being pursued in govt., academia, and industry, the subset of which is by no means already understood, but includes the obvious solutions such as:

1. Single centralized global broker of TH cells.
2. Multiple distributed and coordinated local brokers of TH cells for local users.
3. Ad-hoc “mesh” networking.
4. Fixed assignment
5. Hybrid approaches.

2) Prioritize and cull the list from most likely to succeed to least likely to succeed. For the top 3-5 approaches, perform and document an exhaustive evaluation of advantages and disadvantages compared to competing approaches, and including the existing frequency management scheme currently implemented within the US. This evaluation will also include the relevant cost analysis of a large scale rollout, both for complete national plan or a scaled-down DoD plan. It should also include initial modeling and simulation of the the various approaches. 3) Recommend: The culmination of phase I will be a recommendation, based on supporting analysis, of one best approach to topic solution, and a well-designed plan for executing a prototype demonstration of the selected approach in phase II.

PHASE II: This second phase will involve modeling, simulation, development, testing, verification, and demonstration of a prototype for the topic solution approach resulting from phase I evaluation, to prove the concept in some minimal realistic over-the-air context, the details of this task to be determined largely by the progress and discoveries made during phase I and the proposal process. Given that the recommended solution may be costly to implement, it is imperative that the modeling and simulation portions of phase II be emphasized for optimal risk assessment and management.

PHASE III DUAL-USE COMMERCIALIZATION: The dual use commercialization potential of this ubiquitously relevant technology as bandwidth is an issue for both military and commercial communications systems and networks. In phase III, it would remain for the offeror to take the demonstrated concept to market, most likely in incremental steps as demand and support for a major paradigm shift mounts. In particular, a “build it and they will come” philosophy along with partnership by DoD in first developing the fielded version for DoD frequency bands is certainly applicable.

REFERENCES: N/A

KEYWORDS: spectrum management, electromagnetic, transmission, radio frequency, multi-dimensional, hypercube, joint optimization, multi-objective optimization

OSD03-027 TITLE: Information Fusion System for Counter-Terrorism Operations

TECHNOLOGY AREAS: Information Systems

TITLE: Information Fusion System for Counter-Terrorism Operations

KEY TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Develop a novel system for the fusion of intelligence information that arises from multiple sources, e.g., humans, signals, imagery, open-source, news stories, etc. that explicitly accounts for the uncertainty in the data.

DESCRIPTION: Today, most information fusion for counter-terrorism (or anti-terrorism) is done primarily by human operators who have many years of experience and a knowledge base from which to accurately characterize events in real-time. The reliability and the uncertainty in the resulting intelligence analysis reports are proportional to the level of knowledge and the experience of the intelligence officer who developed it. In addition, many intelligence gaps arise from: 1) security compartmentalization between agencies, 2) the tendency to request information based on geographical considerations rather than ideological or cultural concerns, 3) the technological challenges entailed in automatically and accurately processing human intelligence information, and 4) the inability to model and fuse the uncertainties in multi-source information. We are usually able to quantify the error associated with hardware sensors and the associated processing of their output (that is, uncertainties arising from algorithm assumptions, data reduction, transmission loss, etc.). However, it is more difficult to quantify the uncertainties in open-source and human intelligence information, which should be accounted for. Of particular concern is the ability to quantify the uncertainty in web-based open-source information, since the pedigree of that data is often completely unknown. We seek to explore new and creative technologies for the fusion and aggregation of multi-source information with the goal of explicitly quantifying the uncertainty in the final result, given our knowledge of the errors associated with various stages of the data collection and fusion process. Some issues that might be addressed are near real-time operation of the prototype system, scalability of algorithms, incorporation of cultural knowledge and associated uncertainties, fusion of social network analyses, text processing of open-source documents and news stories, estimation/fusion/propagation of uncertainty, and provision of the rationale (expert judgment, weights, etc.) for the values provided. The end result from the system will be intelligence analyses for counter-terrorism or other decision-making systems whose accuracy and dependability are quantified based on mathematical techniques and not on the cognitive abilities and experience of the analyst.

PHASE I: Describe and develop innovative methodologies and a high-level system design for algorithms and/or tools that will aggregate and fuse multi-source data and explicitly integrate all applicable uncertainties in the knowledge.

PHASE II: Design, develop and implement a prototype system that incorporates the framework and algorithms developed in Phase I.

PHASE III DUAL USE APPLICATIONS: The need to aggregate uncertain information is not limited to the counter-terrorism application, so the algorithms and techniques developed on this effort could be used in any decision support system. In addition, the ability to counter terrorism is of concern to the military, other government agencies and industry (e.g., transportation sector, medical community, power companies, etc.). In general, the ability to fuse multi-source information while accurately accounting for uncertainty can be used by both industry and the military for strategic planning.

KEYWORDS: Information fusion, uncertainty, error propagation, decision making, social networks, cultural knowledge, open-source information, text processing, probability and statistics

REFERENCES:

1. Valet, L., G. Mauris, and P. Bolon, 'A statistical overview of recent literature in information fusion,' IEEE Aerospace and Electronics Systems Magazine, 16 (3), March 2001, pp. 7 - 14.
2. Ye, N., V. Nguyen, and G. C. Runger, 'Assessment of operation plan performance under uncertainty,' IEEE Transactions on Systems, Man and Cybernetics, Part C., 31 (2), May 2001, pp. 256 - 260.
3. Hall, D. and J. Llinas, 'An introduction to multisensor data fusion,' Proceedings of the IEEE, 85 (1), Jan 1997, pp. 6 - 23.

KEYWORDS: Information fusion, uncertainty, error propagation, decision making, social networks, cultural knowledge, open-source information, text processing, probability and statistics

OSD03-028

TITLE: Information Uncertainty Portrayal

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Defense Modeling and Simulation Human Performance Program

OBJECTIVE: The objective is to identify innovative methods for portraying information for decision makers so that data uncertainty as well as content is readily understood.

DESCRIPTION: Modern battlespaces and their information are becoming more complex and fluid as the number of objects and events that can be tracked simultaneously increases. To further complicate the decision makers' problem, each event in the battlefield is associated with some varying degree of uncertainty. Further, the uncertainty value of potentially important events can not be assessed in isolation, but needs to be judged in relation to other events happening at the same time in the same location as well as events happening at the same time at other locations. Because objects and events in any given battlespace interact, and change rapidly, the degree of complexity of the information used by decision makers can easily overwhelm commanders and other decision makers. Consider a commander who must make decisions based on information gathered from several different staff members and observer sightings. He must develop a set of goals (or missions) and a mental model of the battlespace, and then use this model in his or her decision making. When forming the mental model, the commander needs to be aware of the disposition and capability of both friendly, enemy, NGO, civilian, and neutral forces. Uncertainty is a key element of all of these components of information, but current information visualization techniques fail to help the commander to the required degree since they do not provide the commander with information concerning the degrees of certainty associated with individual or aggregated information elements. Battlespace visualization techniques are needed that allow uncertainty to be portrayed effectively and grouped intuitively. Modeling and simulation are promising technologies to host the development of potential solution concepts. These concepts may include intelligent agents or other techniques that can assess data uncertainty.

PHASE I will identify a demonstration domain and determine (or devise) methods to compute and portray data uncertainty in the battlespace decision-making context. Metrics for benchmarking the utility of selected methods in terms of better decision making (e.g., fewer errors, faster decision cycles) will be used in determining feasibility and user value.

PHASE II will develop a production-scalable prototype, to include a domain-specific ontology and lexicon. This prototype will provide the commander with an individualized and seamless capability to better locate, correlate, and evaluate data for decision-making.

PHASE III DUAL USE APPLICATIONS: Dual Use applications are very likely. They include state and local government emergency response systems in various homeland security scenarios. Systems like this are also finding important applications in the financial industry for investment decision making and risk management.

REFERENCES:

1. Tufte, Edward. (1997). Visual explanation: images and quantities, evidence and narrative. Graphics Press.
2. Tufte, Edward (1990). Envisioning information. Graphics Press.
3. Wooldridge, M. & Jennings, R. (Editors) (1995). Intelligent Agents - Theories, Architectures, and Languages Springer-Verlag Lecture Notes in Artificial Intelligence, Volume 890.

KEYWORDS: Decision making, intelligent agents, information visualization, battlespace awareness

OSD03-029

TITLE: Portraying Uncertainty in Battlefield Weather Situational Awareness

TECHNOLOGY AREAS: Information Systems, Battlespace, Human Systems

OBJECTIVE: Develop a method to visualize the uncertainty associated with a weather forecast-based decision aid.

DESCRIPTION: Weather forecasts are inherently uncertain. Direct users of a weather forecast may be given a probability of certain weather, or a range of possible values. Currently on the battlefield, the time and personnel available mandate the use of automated weather forecasts and associated weather decision aids. The automated weather forecast models are deterministic producing a single value of each weather parameter for each forecast time. These individual values are then used to drive automated decision aids, such as the Integrated Weather Effects Decision Aid (IWEDA). Users of these decision aids may be provided a favorable/marginal/unfavorable" output based on predicted atmospheric conditions for specific military missions. They may also be told the actual weather forecast value leading to an unfavorable weather impact. However, this information is often insufficient or misleading without knowing the expected accuracy of the original weather forecast value. This SBIR topic requires (1) the investigation of methodologies to generate levels of uncertainty in automated weather forecasts, and (2) the development of visualization strategies to portray the uncertainty in weather-based decision aids. The Army forecast and decision aids are available on the fielded Army weather system, the Integrated Meteorological System (IMETS), which receives weather forecast model data from the Air Force using MM5 (Penn State/NCAR Mesoscale Model version 5). Methodologies developed under this SBIR would be expected to be able to be implemented on the IMETS, as well as be applicable to Air Force, Navy, and civilian applications.

PHASE I: Develop one or more methods to generate modified data from numerical weather forecast model(s) output to incorporate the amount of uncertainty associated with the original forecast. Design a concept for portraying decision aids based on the modified data to relay the associated uncertainty or level of confidence in the automated weather-based decision aid to decision makers.

PHASE II: Develop and demonstrate the operation of a prototype software weather decision aid module incorporating relevant information on the forecast uncertainty to human decision makers. The module should be driven by a 4-D (3 dimensions in space plus time) grid of weather forecast parameters.

PHASE III DUAL USE APPLICATIONS: Tri-service command and control systems are expected to run a future version of the IWEDA decision aid software described in Reference 1 below. Various route-planning software systems need weather forecast data to depict hazard-avoidance decision aids. In addition, individual soldiers could have short-term weather-based decision aids running on Personal Digital Assistants, such as heat stress warnings. Each of these systems would benefit from a method or software module to visualize the weather forecast uncertainty associated with the decision aid. In addition, National Weather Service and private weather forecast companies could provide similar products to customers wanting to make cost/benefit decisions relating to the weather forecast.

REFERENCES:

1. Sauter, David, "An Interactive Information and Processing System to Assist the Military with Command and Control Decision Making", Proceedings of the 16th Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology. American Meteorological Society, Long Beach, CA, 2000.
2. Pielke, Jr., Roger A., "Evaluation of the Societal "Goodness" of Forecasts: A Review and Assessment", Proceedings of the 14th Conference on Probability and Statistics in the Atmospheric Sciences. American Meteorological Society, Phoenix, AZ, 1998.
3. Stewart, T.R., 1997: Forecast value: Descriptive decision studies. In: R.W. Katz and A.H. Murphy (eds.), Economic Value of Weather and Climate Forecasts. Cambridge, UK: Cambridge University Press, 147-181.

KEYWORDS: weather forecast; situational awareness; uncertainty; decision aid

OSD03-030

TITLE: Leadership Agent for Multi-source Information Fusion in Counter-Terrorism

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: For tasks such as tracking terrorists, and integrating information from multiple sources, leaders urgently need improvements to search technology that incorporate assessments of ambiguity and uncertainty and operate over multiple languages.

DESCRIPTION: Leaders searching for information from large heterogeneous data sources, such as collections of intercepted messages or fragmentary intelligence reports confront an important and difficult problem. The modern battlespace is a complex, rapidly changing, uncertain environment. With every event in a battlespace, there is an associated uncertainty. The uncertainty of an event or combination of events changes with time. In addition, the uncertainty of potentially important events cannot be assessed in isolation. Instead, uncertainty is judged in relation to other events that have, are happening or may happen in various locations. Decision-making requires a complex model, not currently available to commanders. Novel techniques that integrate information from multiple sources, and properly account for uncertainty of information are required. The state-of-the-art in search technology (keywords; Boolean combinations; Bayesian probabilities) is far from perfect and not very effective for targets that are "trying to hide" by either using unfamiliar terminology or intentionally misusing common terminology. Unfortunately, both situations are common in terrorist communiqués. For such tasks substantive improvements in search technology that incorporate assessments of ambiguity and uncertainty are urgently needed.

Searching for information with available search technology is analogous to thinking of one town where an enemy might be hiding, dropping down on it, then, if empty, trying another town of the same or similar name or size, no matter how far away. The reason for this awkward hit-and-miss approach is that all current search engines use one of three methods. They either: (1) try to match one or a few words in a query with the same few words in the quarry (keywords) or (2) look in the places where greatest number of other people have looked (Probabilities), or (3) have humans categorize the kinds of places that targets of interest are most likely to be (Bayesian). However, in the physical world a skilled hunter, whenever possible, tracks the quarry, follows its spoor from place to place, paying close attention to the direction of movement, tracing by multiple clues from cooler leads to hotter.

To do the same sort of hunting in the information world, a search technology needs to be able to relate documents or messages to each other not just by a few selected words, but by anything that ties them together; that is, all of their contained "meanings", no matter what words they are expressed in. One could then examine particular relations between the current neighborhood and surrounding areas in "meaning space" and follow trails based on any clues that come to light.

PHASE I: Phase I will produce an experimental prototype system (working with documents and transcripts of conversations numbering in the thousands) that demonstrates the functions described above sufficiently well that the feasibility and utility of a fully functional system (dealing with documents and transcripts in the millions) can be evaluated by both informal examination and formal testing using a variant of standard information filtering metrics in which an interacting human user is in the loop.

PHASE II: Phase II will produce a completely functional prototype system capable of trial use and user-centered evaluation and redesign for use with any electronically transmitted language.

PHASE III Dual Use Commercialization Potential: The system will be valuable for use by all military, security, and intelligence organizations, and should be actively marketed there. It will also be valuable for non-military security, law enforcement, and forensic applications. A range of civilian uses would also be of commercial and public service value, such as an electronic clipping service to run over the content of the various national and international newswires, or over the contents of electronic libraries such as the Library of Congress.

REFERENCES:

- Dumais, S. T. (1996). "Combining evidence for effective information filtering." In AAAI Spring Symposium on Machine Learning and Information Retrieval, Tech Report SS-96-07, AAAI Press, March 1996.
- Letsche, T. A., and Berry, M. W. (1997). Large-scale information retrieval with latent semantic indexing. *Information Sciences Applications* 100:105-137.
- Littman, M.L., Jiang, F., and Keim, G. A. (1998). Learning a language-independent representation for terms from a partially aligned corpus. In Shavlik, J. (Ed.), *Proceedings of the Fifteenth International Conference on Machine Learning*, 314-322. Morgan Kaufmann.

KEYWORDS: Information fusion; retrieval; terrorism; leadership; knowledge management; uncertainty; ambiguity; multiple meanings

OSD03-DH01 TITLE: Optimized Off-the-shelf Portable Trap for Haematophagous Arthropods

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Design a trap for military risk evaluation of biting insects and ticks, taking into consideration the need for the trap to be light weight, rugged, accurate, and field transportable.

DESCRIPTION: Biting ticks and insects are the source of diseases like malaria and dengue that can decimate entire units of American service members. Military preventive medicine teams are sparsely distributed on the battle field, so that resources to control biting ticks and arthropods need to be carefully targeted to those areas of greatest concern. The current devices in the standard Entomological Collecting Kit for sampling insects and ticks use technology that is over 30 years old. Neither the standard light trap nor the cloth tick drag are sensitive methods, therefore requiring the use of much duplication of effort. New technology to produce attractive odors for biting ticks and insects is now available. Packaged together with self-contained trapping devices, these sources of odors could produce a smaller, more rugged, and more accurate trap than what is currently in the inventory. The trap will perform at least 20 hours on installation. Each trapping unit with generation materials should have a warehouse storage life of at least 5 years (-15 to 100°F) and be shipped with no special handling. Ease of use and transportability will allow widespread deployment and logistical support of this trap in remote theatres to enable consistent vector monitoring wherever troops are deployed.

PHASE I: Develop a trap design that optimizes mosquito capture using carbon dioxide generation technology, supplemented by specific attractants. Optimize the geometry of the delivery system so that the shape of the attractant odor plume provides the best concentrations over the widest possible area. Test prototype in the field relative to existing commercial traps.

PHASE II: Manufacture sufficient units to provide material for field testing in areas where important species of malaria mosquitoes, dengue mosquitoes, and leishmaniasis sand flies exist.

PHASE III: The product from this project would have great potential for dual use application. Mosquitoes are responsible for the greatest number of arthropod-borne illnesses in the world. In the U.S., West Nile Virus constitutes a significant emerging public health threat. The WHO and other international health organizations use thousands of traps throughout the world, often in very remote or primitive locations. An effective, user friendly, compact and self-contained product for mosquito trapping could be used by literally millions of customers in the U.S. and abroad for detection and suppression of mosquitoes transmitting dengue, malaria, West Nile Virus and other fevers -- all diseases of major public concern. The environmental safety of such a product would make it suitable for both public and residential in areas where people often encounter mosquitoes and other biting fly vectors.

KEYWORDS: mosquito, trap, carbon dioxide, infectious disease, force multiplier, force protection, risk assessment, infectious disease

OSD03-DH02 TITLE: Biological Effects Pattern Recognition Tool Using Multivariate Statistical Data Reduction

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To develop a multivariate statistical analysis software tool for measuring and interpreting complex, time-related, global changes in gene, protein and metabolite expression pattern profiles that will identify toxic substances exposure at very low, subtoxic concentrations to military personnel.

DESCRIPTION: Low-level exposure of toxic chemicals and materials has become an important issue in personnel force protection with chemical exposure potential at diverse deployment sites. Operational environments, from theater-level combat to humanitarian missions, for these deployed personnel may contain toxic chemicals and materials as a result of industrial accidents, intentional or unintentional activities of various forces (enemy or friendly) or sabotage. Current methods of determining an adverse exposure to the warfighter are not considered adequate to prevent long-term serious health effects such as that induced by Agent Orange in Vietnam, or are they sufficiently sensitive to predict, and therefore prevent, a Gulf War-like Syndrome disease. Rather than fully defining a complex mixture environment using chemical measures, a rapid risk assessment of these uncharacterized environments will require the development of recently evolved methodologies with testing based on human health changes at a subclinical, disease-free response. The emerging biotechnology techniques in gene (transcriptomics/genomics), protein (proteomics), and metabolite (metabonomics) expression, will be able to identify toxic effects upon an individual before any decrease in normal activities or establishment of a disease process that may not be manifested initially or post-exposure. However, to accurately predict potential health effects using these emerging biotechnologies, methods will be required to assess biologically relevant meaning to exposure occurrence. The emerging biotechnologies described above will give rise to enormous amounts of data that will be stored in databases. These data must then be compared between species to identify corresponding pattern profiles from exposures occurring in humans and animals. Comparing gene, protein and metabolite expression pattern profiles, when a significant amount of variability is present, is a complex statistical problem and is presently within a sub-discipline of bioinformatics. Operationally, bioinformatics is the collection of data and its manipulation to obtain understanding of biological processes, and in this case prediction of change in health status. Using the present off-the-shelf high-powered computing capabilities with a specifically designed software package, prediction and identification of potential hazardous exposures, or any environmental challenge, to the human can be attained.

PHASE I: Develop and demonstrate a prototype multivariate statistical software tool to reduce multidimensional data generated by genomic, proteomic and metabonomic technologies and make accurate assessments, based on data set patterns, of low level exposure to hazardous compounds. The effort should clearly address unique evaluations of the toxicological hazards associated with low-level chemical exposures prior to the onset of overt toxicity, and statistical methods to rapidly access and analyze multivariate, diverse data format types available in various biotechnology platforms (e.g. genomics, proteomics and metabonomics).

PHASE II: Finalize and validate prototype multivariate statistical software tool specified in Phase I.

PHASE III: DUAL USE COMMERCIALIZATION: Follow-on activities are expected to be aggressively pursued by the offeror in seeking opportunities to integrate software into various biotechnology platforms (genomics, proteomics and metabonomics). Commercial benefits include identification of toxic effects upon the occupational worker before they can cause any decrease in performance or induce a disease process that may not be manifested during duty occupational pollution. Uses also include preventative medicine human health monitoring for hazardous exposure at manufacturing facilities, for movement cadence after time of exposure monitoring for workers, or for the local inhabitants to industry areas concerned with environmental pollution that is associated with industry where industrial starting materials, processes, or products have the potential to cause sickness.

REFERENCES:

- 1) Burchiel, S.W., Knall, C.M., Davis, J.W. 2nd, Paules, R.S., Boggs, S.E. and Afshari, C.A. Analysis of genetic and epigenetic mechanisms of toxicity: potential roles of toxicogenomics and proteomics in toxicology. *Toxicol Sci.* 59(2): 193-5, 2001
- 2) Fielden, M.R. and Zacharewski, T.R. Challenges and limitations of gene expression profiling in mechanistic and predictive toxicology. *Toxicol Sci.* 60 (1): 6-10, 2001
- 3) Smith, L.L. Key challenges for toxicologist in the 21st century. *Trends Pharmacol Sci.* 22(6): 281-5, 2001
- 4) Trifonov, E.N. Earliest pages of bioinformatics. *Bioinformatics.* 16(1), 5-9, 2000
- 5) Rice, C.M., Fuchs, R., Higgins, D.G., Stoehr, P.J., & Cameron, G.N. The EMBL data library. *Nucleic Acids Research.* 21(13), 2967-2971, 1993
- 6) Benson, D., Lipmann, D.J., & Ostell, J. GenBank. *Nucleic Acids Research.* 21(13), 2963-2965, 1993
- 7) Laxminarayan, S.N. Biomedicine in the 21st century; impact of information technology. *IEEE Transactions on Information Technology in Biomedicine.* 3(1), 2-5, 1999

KEYWORDS: bioinformatics, gene expression profile, multivariate statistics, deployment toxicology, proteomics, metabonomics, pattern recognition, data reduction, human, warfighter health

OSD03-DH03

TITLE: Advanced Force Protection Tools (AFPROT) for Integrated Mission Planning

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: To develop computational tools for use in mission planning that address scenario-specific toxic industrial chemical/material (TIC/TIM) exposure hazards for operational personnel.

DESCRIPTION: Intelligent (computational) assessment of potential toxic industrial chemical/material (TIC/TIM) exposure hazards is necessary for 21st century military mission planning. Increasingly, the modern battlespace engages industrialized areas. Currently, only rudimentary estimations can be made of the human health hazards associated with personnel exposures during operations in complex industrial chemical-rich environments. Simple knowledge of TIC/TIM presence or toxicity level is virtually useless in a planning context associated with personnel movement and other mission efforts. Thus, a near real-time hazard assessment system is needed to assist in the planning process that accounts for scenario-specific factors during deployment. Factors that would influence the potential effects of chemicals include, and are not limited to, the length of the operation, the potential routes of exposure (e.g. inhalation, skin absorption, drinking water), the availability of personal protective equipment, weather conditions, and the availability of reliable toxicity (health hazard) information. Furthermore, the amount of intelligence information that must be electronically gathered and parsed for decision analysis, including chemical hazard information, clearly requires the assistance of computational tools to produce simple decision assessments for command officers. The Advanced Force Protection Tools (AFPROT) approach would aid in assessing potential threats before deployment, as well as updating contingency planning during operations. An AFPROT solution would be integrated to support current and future command and control (C2) systems, including base level chemical exposure modeling and various mission planning tools. This approach reflects current efforts that consider the potential for biological agent exposure to impact mission effectiveness, morbidity and mortality. However, a similar approach is not available to completely address the potential hazards to personnel, a concern especially relevant to special operation missions, due to scenario-specific TIC/TIM exposure. A successful automated AFPROT approach would address these important issues.

PHASE I: Demonstrate the capability for rapid access of TIC/TIM health hazard information for incorporation into a knowledge-based predictive system. This approach should demonstrate, through computational performance, the capability for inclusion of chemical intelligence data, as well as importing necessary data from key database systems.

PHASE II: At this stage, the AFPROT approach would focus on adapting the Phase I approach to include real-time data acquisition and updating. A key element of Phase II would be demonstrating effective decision-planning tools based on scenario-specific parameters for TIC/TIM hazard predictions.

PHASE III: DUAL USE APPLICATIONS: The AFPROT approach must be made compatible with other DoD C2 systems to support mission planning. Moreover, this tool has direct applications to Homeland Defense and First Responder protection concerns. The tool set could be used for contingency planning in the event of industrial accidents, as well as acts of terrorism.

REFERENCES:

- 1) Henry K. & Silva J., "Enhanced Consequence Management, Planning and Support System (ENCOMPASS). Enabling an effective, coordinated response," Emerg Med Serv, Apr;31(4):52-9, 2002.
- 2) Kleinbaum D.G., "Epidemiologic methods: The art in the state of the art," J Clin Epidemiol, Dec;55(12):1196-200, 2002.

3) Liebowitz, J., "Expert systems and uncertainty," In The Handbook of Applied Expert Systems. CRC Press:Boca Raton. pp.8/1-8/11, 1998.

4) Lopez, C.T., "Software improves accuracy, quickens air war planning," Air Force Print News, Feb 7, 2003. (<http://www.af.mil/news/Feb2003/20703291.shtml>)

KEYWORDS: computational, toxicology, command and control, Human Effectiveness, health risks, chemical hazards, homeland defense, force protection, toxic industrial chemicals, toxic industrial materials

OSD03-DH04 TITLE: Deployable Simulation Training for Operational Medical Personnel & Emergency Responders

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: To research and develop an intelligent simulation training environment to support operational medical professionals on station and in a deployed status.

DESCRIPTION: Military medicine currently lacks a capability to develop and deploy realistic, mission oriented training to personnel. Medical professionals need a means of accelerating the acquisition of expertise in decision-making and team coordination that underlies responses to chemical, biological and radiological (CBR) threats. Currently, almost all of the training for deployable medical personnel occurs in the field in an on-the-job training mode and focuses on the acquisition of procedural knowledge. There is no advanced simulation capability for use in training the high level decision-making associated with assessment and response to CBR threats. This severely limits the capability of training organizations to rapidly produce "mission ready" personnel for the field. This same training deficiency hinders mission performance for the deploying forces, both ground based medical personnel and air evacuation medical personnel. This effort requires innovative approaches to conduct analyses of the current and potential future threat environments in which ground based medical crews and aerospace medical personnel are expected to operate. This effort could develop, for example, a template for development of simulation scenarios for familiarizing medical professionals with the CBR threat detection, assessment and countermeasures. The training simulation approach should provide medical personnel with a high fidelity, mission-oriented training capability for emergency response and rapid deployment. The developed technology should provide comprehensive personnel training and rehearsal capability related to critical medical training. The objective is not to development of simulators for training procedural knowledge related to CBR equipment but rather simulations for training decision-making and team coordination. The goal is to provide medical forces with a deployable capability that can be used at the home duty station, on transport aircraft in route to deployment, for ground bases, and within theater. Proof-of-concept technologies and training content will be developed as demonstrations.

PHASE I: Demonstrate the feasibility to develop a deployable training simulation technology to support crew and aerospace medical personnel in a simulated environment specifically designed for threat scenarios. Training technology deployment and Concept of Operations (CONOPS) assessment should be used to support the training capability.

PHASE II: Develop and demonstrate a prototype deployable training simulation technology for military medical personnel. The test bed for the proposed project will be medical training. All data collection activities and field delivery and evaluations of developed training content and technology alternatives are to be documented. Results will be used in an iterative development and demonstration process.

PHASE III: Dual-Use application will result with the transition of deployable training technology to specific areas in need of ground-based training environments for medical teams, first responders, aircrew, security forces, and maintenance personnel. This technology will provide a realistic continuation training using realistic simulated training environments and will support ground crew chemical, biological, and radiological protection methods. Application is intended for US medical personnel and allied forces.

REFERENCES:

1. Issenberg, B.B., McGaghie, W.C., Hart, I.R., Mayer, J.W., Felner, J.M., Petrusa, E.R., Waugh, R.A., Brown, D.D., Safford, R.R., Gessner, I.H., Gordon, D.L., Ewy, G.A. (1999). Simulation technology for health care professionals skills training and assessment. JAMA; 282:861-6.
2. Gorman, P.J., Meier, A.H., Krummel, T.M. (1999). Simulation and virtual reality in surgical education: real or unreal? Arch Surgery; 134:1203-8.
3. La Mura, F. (2001). The use of distance learning & simulation in the European masters of disaster medicine. Proceedings of the 12th International Training, Education and Simulation Conference. Lille, France. April.
4. Sorensen, H. B. (2000). Joint medical training and international systems. Proceedings of the Joint Medical Simulation and Training Conference. The Hague, Netherlands. April.
5. Torkington, J., Smith, S., Rees, B.I., Darzi, A. (2000). The role of simulation in surgical training. Ann R Coll Surg Engl; 82:88-94.
6. Moses, G. (2001). Military medical modeling and simulation in the 21st century. Proceedings of the 12th International Training, Education and Simulation Conference. Lille, France, April.

KEYWORDS: Deployable training, medical personnel, intelligent simulation, NBC threat, advanced training technology, emergency response

OSD03-DH05

TITLE: Training Military Medical Personnel for Respond for Directed Energy Weapons and Technology Casualties on Humanitarian Missions

TECHNOLOGY AREAS: Information Systems, Biomedical, Sensors, Electronics, Human Systems, Weapons

ACQUISITION PROGRAM: Combat Casualty Care

OBJECTIVE: Utilize basic and applied Directed Energy Weapons (DE) bioeffects research to develop Combat Casualty Care training for emerging technologies and weapons.

DESCRIPTION: Communication, military radar, lasers, range finders, laser designators, weapon detection devices, directed energy and millimeter wave non-lethal technologies are being developed that make use of electromagnetic fields. With the increasing use of these emerging directed energy technologies, there is the need for casualty care providers to have a basic understanding of the biological and health effects of exposure to varying electromagnetic frequencies.

Combat Casualty Care training must be able to assess injuries, identify treatment protocols, develop triage and appropriate care processes. Such medical capability will be necessary to reduce directed energy casualties and enhance unit combat effectiveness.

Combat Casualty Care management requirements on humanitarian missions must be defined for survival, delivery of care and protection of patients in Directed Energy Weapons use environments.

This process must include data collection to:

- evaluate the medical impact of emerging DE weapons and Bioeffects
- obtain appropriate medical intelligence and permit maximum medical access to all aspects of directed energy programs
- develop specialized medical treatments
- define protection methods for personnel and material
- develop non-ionizing radiation dose sensors
- continuously monitor emerging directed energy technologies and their bioeffects
- continuously update training and treatment doctrines, based on scientific data analysis, for medical management of specific directed energy threats
- identify, address and provide appropriate security information to deployed personnel exposed to directed energy threats

Develop a process design to identify training requirements and rapidly integrate emerging directed energy technology information into combat casualty care training programs.

Process design should facilitate Triservice Combat Casualty care doctrine updates, identification of treatment options for the provision of care, identify transport constraint requirements, improve medical capability available to theater commanders, and maintain the strength of the fighting force. These are essential requirements in providing intervention/treatment, at the point of care.

Preliminary survey data from active duty and reserve medics establishes that medics surveyed had a very limited understanding of Directed Energy weapons systems in relation to potential directed energy casualty care requirements. On time, medical provider training for DE injuries will promote standardization and interoperability of directed energy Combat Casualty Care management at all echelons.

This training will provide:

- appropriate hazard identification
- establish assessment criteria
- establish communication procedures (command, control, communications)
- identify appropriate triage and treatment protocols
- enhance the individual's timely access to acute care management
- identify health & psychological effects
- ensure standardization and interoperability of Combat Casualty Care training readiness programs
- develop database for injury trends and treatment outcomes and integrate with existing databases, e.g. USAF
- modify after-action reporting to assess medical outcomes
- provide accurate risk communication of potential injuries (unfamiliarity, intensity, ambiguity of threat of these technologies may result in some individual's having stress responses and unprepared traumatized civilians may require care
- war fighters are combat ready and recognize possibility of injury, but it is also important to train for increased psychological care requirements in the deployed setting

PHASE I: Develop a centralized Directed Energy Combat Casualty Care training program and information process. Establish a process that integrates directed energy and Combat Casualty Care research data for timely application for medical providers training. DE Combat Casualty Care training manual will be based on the published scientific literature regarding non-ionizing radiation dosimetry and health effects.

PHASE II: Develop and implement a centralized Triservice program. This program will continuously monitor and update the training course and manual that were outlined in Phase I. An assessment tool must be developed that will measure the strengths and weaknesses of the directed energy training course.

PHASE III DUAL-USE COMMERCIALIZATION: The Triservice training course and manuals would be valuable to casualty care providers in government, military, humanitarian and private medical environments.

REFERENCES:

1. Department of the Air Force. Headquarters Human Systems Center HSC/XRM. Human Systems Center Development Plan for Operational Medical Support. (September 1996). Brooks Air Force Base, TX, 78235. Critical technology document authorized to the Department of Defense and U.S DoD contractors only.
2. Scholl, D., Peterson, R. and Moreno, C. (2003). Radiofrequency Radiation Assessment Tool for Medical Personnel. (Technical report being prepared).
3. . Durney, CH, Massoudi, H., and Iskander MF (1986): Radiofrequency Radiation Dosimetry Handbook (Fourth Edition), USAFSAM-TR-85-73, USAF School of Aerospace Medicine, Brooks Air Force Base, TX, 78235.
4. Adair, ER, Mylacraine, KS, and Cobb, BL. Human exposure to 2450 MHz CW energy at levels outside the IEEE C95.1 Standard does not increase core temperature. Bioelectromagnetics, 22: 429-439, 2001.
5. IEEE/ICES Homepage (<http://grouper.ieee.org/groups/scc28>)
6. United States Army Medical Research Institute of Chemical Defense (USAMRICD) <http://ccc.apgea.army.mil/Documents/RedHandbook/001TitlePage.htm>
7. United States Army Medical Research Detachment <http://army.brooks.af.mil>

8. Doswald-Beck L. Blinding Weapons. 1993. International Committee of the Red Cross Geneva. 272-292.
9. Medical Readiness Plan 1998-2004 DoD 5136.36.1-P.
10. Non-Lethal Weapons DoD Directive 3000.3.

KEYWORDS: Non-ionizing radiation , Dosimetry , Bioeffects, Health effects, Combat Casualty Care, Triservice, Joint Services, Directed Energy, Lasers, Millimeter Wave, Microwaves, Radio Frequency Radiation

OSD03-DH06

TITLE: Predicting Cognitive Performance of Deploying Health Teams

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: To design and develop unobtrusive techniques and methodologies to predict individual and team readiness to perform critical mission objectives.

DESCRIPTION: US military operations and training to support those operations are undergoing rapid changes. Deployment of geographically dispersed and competent military medical teams throughout the world requires operationally trained personnel to be prepared to manage all threats and employ all contingencies. Currently, these medical teams and their missions are comprised of individuals differing in competency skill levels within the field of medicine as well as allied fields of intelligence, communication, and security across domains of air, land, sea and space. In addition, these rapidly generated teams may originate from different geographical locations and varied operational missions. To further hinder the mission, individual team members likely are unfamiliar with each other, have limited knowledge of the deployment location, and are not trained in the specifics of the tasks to be performed. It is essential that cognitive assessment begins at the initiation of the assignment and continues through arrival at the theater of operation. However, traditional training and operational methodologies and strategies deter the individual and team in cognitive development and the assessment for critical mission capabilities. What is needed are methodologies and techniques to non-invasively measure the cognitive capability of an individual to comprehend and carry out medical mission requirements under varying threats and contingencies and use these measures to predict cognitive readiness of individuals and teams for medical readiness.

PHASE I: Design a creative set of measurement techniques for field use to unobtrusively assess the cognitive state of individual and health team readiness for mission and deployment. Demonstrate the impact on readiness with use of these assessment tools, and the diversity of these tools across individual and joint medical missions. Phase I documentation to include initial plan for development measures, the effectiveness of measures of cognitive readiness, and potential commercial applications.

PHASE II: Based on Phase I design plans, produce a functional prototype predictive cognitive model for cognitive readiness applicable for medical health teams across military services. A test and evaluation plan with a full demonstration of capabilities will be performed. Provide detailed technical report and commercialization plan.

PHASE III DUAL USE APPLICATIONS: The commercial viability of assessing and predicting cognitive medical readiness will be demonstrated. Use in both DoD and commercial sectors (global humanitarian missions, emergency readiness, etc.) will be pursued.

REFERENCES:

1. Guerlain, S.A., Smith, P.J., Obradovich, J.H., Rudmann, S., Strohm, P., Smith, J.W., Svirbely, J., & Sachs, J. (1999). Interactive critiquing as a form of decision support: An empirical evaluation. *Human Factors*, 41, 72-89.
2. Militello, L.G., & Hutton, R.J.B. (1998). Applied cognitive task analysis (ACTA): A practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, 41, 1618-1641.
3. Spector, J.M. (2000). Gagne's influence on military training research and development. In R. Richey (Ed.), *The legacy of Robert M. Gagne*. Syracuse, New York: ERIC-IT Clearing House and IBSTPI.
4. Zachary, W.W., Ryder, J.M., & Hicinbotham, J.H. (1998). Cognitive task analysis and modeling of decision making in complex environments. In J.A. Cannon-Bowes & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp 315-344). Washington, DC: APA.

KEYWORDS: cognitive readiness, performance measures, cognitive task analysis, decision making, predictive measures, military readiness, mission performance

OSD03-DH07

TITLE: Distributed Medical Training for Force Mobilization and Disaster Response

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop computer-based training for distributed network delivery that addresses one of 3 DoD needs, using the best available instructional methods informed by cognitive research. These needs are: 1) training for physicians with expertise in certain specialties but who need training in trauma care when mobilized; 2) training for physicians in the broad scope of problems that arise in situations of infectious disease outbreaks and/or emerging epidemics; 3) similar training in the appropriate medical disciplines intended for less highly educated personnel such as physicians' assistants or independent duty corpsmen.

DESCRIPTION: When physicians or other medical personnel are mobilized for military missions and operations, they may confront a range of medical problems with which they have little prior experience. The desired instructional developments should aim to close that gap between prior experience and likely demands on their skills with sophisticated modern instruction that includes interactive problem solving with simulated cases. Proposals should reflect cognitive research relevant to medical training, including recent research (cited below) on the effective use of cases in instruction, and not be duplicative of existing instructional systems for medical personnel in DoD. It is expected that multiple awards will be made. Each proposal need not address all of the problems mentioned.

PHASE I: The proposal for Phase I should show evidence of knowledge of relevant cognitive and instructional design research, as well as relevant subject matter expertise and personnel qualifications. The work of Phase I should develop a detailed design for the planned courseware, including the instructional methods to be used. A prototype of interfaces and examples of instructional approaches should be developed. In addition to courseware development plans, plans for evaluation of the courseware in Phase II should be developed in Phase I, and necessary approvals for the use of human research participants should be obtained for the work envisioned in Phase II.

PHASE II: In Phase II, the courseware will be developed, with appropriate formative evaluations in the course of development. The instructional effectiveness should also be evaluated with an appropriate population.

PHASE III DUAL-USE COMMERCIALIZATION: These products should have civilian and international customers in addition to DoD.

REFERENCES:

- (1) Anderson, J. R., Boyle, D. F. and Reiser, B. J. Intelligent tutoring systems. *Science*, 1985, 288, 456-462.
- (2) Gott, S.P. & Lesgold, A.M. (2000) Competence in the workplace: How cognitive performance models and situation instruction can accelerate skill acquisition. In R. Glaser (Ed) *Advances in Instructional Psychology Vol. 5: Educational Design and Cognitive Science*. Hillsdale, NJ: Erlbaum, p. 239-327.
- (3) Loewenstein, J., Thompson, L., & Gentner, D. (1999). Analogical encoding facilitates knowledge transfer in negotiation. *Psychonomic Bulletin & Review*, 6, 586-597.
- (4) Evans, D. & Patel, V. (1989) *The Cognitive Sciences in Medicine*. Cambridge, MA: MIT Press.
- (5) Paul J. Feltovich, Richard L. Coulson, and Rand J. Spiro, *Conceptual Knowledge Foundations for Naval Medical Training: A Scheme for Directed Curricular Planning and Instructional Design*. Final Report: Navy Manpower Personnel, and Training R & D Program. Contract No. N00014-88-K-0286 (R & T 4428014) 12 March, 1992

KEYWORDS: Computer-based training, Mobilized trauma care, Physician training, Disaster medicine

OSD03-DH08

TITLE: Facilitating Post-Deployment Data Mining to Evaluate War-Related "Medically Unexplained Symptoms" by Means of Required Structured Data Entry

TECHNOLOGY AREAS: Biomedical

OBJECTIVES: 1) Identify the minimum data elements necessary for capture in theater during medical encounters to facilitate post-deployment epidemiologic analysis of war-related illnesses of unclear etiology. 2) Design a concept for interfacing with existing military medical software programs and the Defense Medical Surveillance System (DMSS) deployment health data repository to ensure recording and retrieval of these data elements.

DESCRIPTION: The phenomenon of war-related "medically unexplained symptoms" (MUS, ICD-9 code 799.6) has been a persistent problem throughout the history of combat. Elucidation of the time course (onset, changes over time) and etiology (cause/effect) in these cases has been hampered by the lack of a longitudinal patient record spanning the pre-, during, and post-deployment continuum. Retrospective analysis relying on patient recall is inherently flawed and suboptimal, due in part to the fact that cognitive impairment, such as memory loss, is a hallmark of the disorder. The military now possesses methods of electronic data capture in theater and storage capabilities that could be exploited to fill in the operational medical data gaps that have existed previously.

A significant amount of literature describing war-related MUS exists, from which can be culled a list of symptoms/signs for data capture in theater that would be most useful for post-deployment evaluation of soldiers with MUS. If non-medical data (eg, time in combat zone, marital status, demographic data, job description, etc) are deemed to be of significant importance upon review of the literature, they should also be considered in the list of required data elements. This required data elements list should be compared and contrasted with the medical and non-medical personnel information the military currently collects pre, during and post deployment.

Data entry by care providers is variable. Providers vary not only in the questions they ask patients and information they elicit at a given clinical visit, but also in the amount and type of information they record. In addition, they may choose to record medical data by means of free text or use of structured data entry (point and click with selections mapped to various codes, such as ICD-9 or Medcin). Required/forced entry fields are sometimes included in clinical encounter software to ensure essential information (eg, patient identifiers) is recorded. Such an approach could be used to ensure capture of the minimal required data elements identified for evaluating MUS. To facilitate user acceptance, however, the number of forced data entries would need to be minimized.

The technical requirements for interfacing with existing military medical software programs and the DMSS deployment health data repository to record and store the minimal required data elements need to be determined. A review of structured data elements that already exist as required entries should be considered in this analysis. Strategies that minimize the healthcare provider time and effort required to enter such data should be favored. Access to military medical information systems such as the Composite Health Care System II - Theater (CHCS II-T), Battlefield Medical Information System Telemedicine (BMIST), and DMSS, as well as to current procedures for mandated pre, during and post deployment data collection and reporting, would be required.

PHASE I: 1) Identify the minimum medical and non-medical data elements necessary to capture in theater for optimizing the post-deployment evaluation of war-related illnesses of unclear etiology. 2) Determine the technical requirements for interfacing with existing military medical software programs and the DMSS deployment health data repository to ensure recording and retrieval of these data elements.

PHASE II: 1) Develop a prototype interface with one of the military theater medical information systems, incorporating the minimal required data elements identified during phase I. 2) Demonstrate the prototype, illustrating the data entry procedure, transfer to the DMSS deployment health data repository for storage, and the ability to extract requested data elements for analysis.

PHASE III DUAL USE COMMERCIALIZATION: The approaches developed in this study, to discern epidemiologically relevant variables and to incorporate data capture for facilitating future data mining, would be of relevance to the study of post disaster disorders and other chronic medical disorders of unexplained etiology (eg, chronic pain syndromes, chronic fatigue syndrome). Innovations in data capture and software interfaces could

attract managed care organizations seeking assistance with resource allocation in the management of these disorders. In addition, approaches similar to those developed in this study could be used to design syndromic medical surveillance systems to detect occult cases of biological, chemical or radiological warfare in the military or civilian environment, which could be of interest to those responsible for local/state/regional disaster planning.

REFERENCES:

1. DOD Directive 6490.2: Joint Medical Surveillance; 30 AUG 97
2. Joint Staff Memorandum MCM-0006-02: Updated Procedures for Deployment Health Surveillance and Readiness; 1 FEB 02
3. Haley RW, Kurt TL, Hom J. Is there a Gulf War Syndrome? Searching for syndromes by factor analysis of symptoms. JAMA 1997 Jan 15;277(3):215-22.
4. Soetekouw PM, de Vries M, van Bergen L, Galama JM, Keyser A, Bleijenberg G, et al. Somatic hypotheses of war syndromes. Eur J Clin Invest 2000 Jul;30(7):566-9.
5. Jones E, Hodgins-Vermaas R, McCartney H, Everitt B, Beech C, Poynte D, et al. Post-combat syndromes from the Boer war to the Gulf war: a cluster analysis of their nature and attribution. BMJ 2002 Feb 9;324(7333):321-4.
6. Liu X, Engel CC Jr, Cowan D, McCarroll JE. Using general population data to project idiopathic physical symptoms in the US Army. Mil Med 2002 Jul;167(7):576-80.
7. Kipen HM, Fiedler N. The role of environmental factors in medically unexplained symptoms and related syndromes: conference summary and recommendations. Environ Health Perspect 2002 Aug;110 Suppl 4:591-5.

KEYWORDS: Medically Unexplained Symptoms, Data Mining

OSD03-DH09

TITLE: Development of Wireless Electronic Information Carrier

TECHNOLOGY AREAS: Information Systems, Biomedical

OBJECTIVE: To develop a secure, encrypted, wirelessly enabled, high capacity electronic information carrier with read/write capability.

DESCRIPTION: The combat medic and military health care provider face significant challenges in meeting their mission of providing battlefield trauma care. Maintaining continuity of care in a rapidly changing environment where casualties are evacuated quickly through multiple echelons of care is often overcome through continual re-assessments of the patient, resulting in wasted time and effort. In a combat environment clinical personnel must inspect the wounded soldier's condition, check the field medical card for care given (if an FMC exists), brief other care givers on the soldier's condition and repeat this process at each evacuation point. In addition, medical regulating officers at every level spend a large amount of time trying to track where the evacuated casualty went in the medical system. In a garrison setting medical records from other clinics, hospitals, and services (or VA, civilian care) are often not available for consideration during treatment. Several different commercial, academic, and DoD organizations have started the process of solving this problem; however, many of the solutions we have studied do not address all of the needs: a electronic storage device with the capacity to hold a 20 year longitudinal medical record, with images; the capability to store and transmit that data in a secure encrypted fashion (end to end); the ability to track the person wearing the device via a GPS; and the ability to read and write data using a wireless topology that will support many platforms. A few of these technologies are currently available or are being developed; however, a full integration of these technologies on a single "dog tag" sized device is needed to eliminate wasted time/effort along the evacuation chain; improve the capture of all care rendered and improve continuity of care in a deployed and garrison setting.

PHASE I: The proposal for Phase 1 should identify commercially available technologies that could be brought together to meet the electronic information carrier functionality listed above with an assessment on whether a completely new device or modifying a currently available device is most effective. A systems engineering design and an interface control document should also be provided.

PHASE II: In Phase II, the actual production of a prototype electronic information carrier with encryption, wireless read/write capability, GPS tracking, and demonstrated integration with DoD Automated Information Systems will be constructed.

PHASE III DUAL USE AND COMMERCIALIZATION: Phase III will be to complete the product from beta prototype to commercial product. FDA testing and evaluation as required, and submission will occur. Cost/benefit studies will be performed.

KEYWORDS: Electronic information carrier; GPS; wireless; patient-centric; medical information carrier; longitudinal medical record

OSD03-DH10

TITLE: Data Mining Longitudinal Clinical Data to Detect Adverse Drug Events

TECHNOLOGY AREAS: Biomedical

ACQUISITION PROGRAM: DOD(HA) PEO IM/IT

OBJECTIVE: Design and develop a data mining tool to assess longitudinal clinical data from existing and evolving DOD health information systems to detect and evaluate adverse events AFTER use of a drug or vaccine has been approved and is underway. Design and prototype screening algorithms/computer systems to efficiently signal higher-than-expected combinations of drugs and events in a longitudinal data base. Potential confounders, such as age, gender, race, calendar year, and geographic (deployment) location will be controlled. Redundant records (consultant and primary physician describing same event) will be eliminated.

DESCRIPTION: The task is to design, develop or adapt a data mining tool to detect both known and unknown safety signals in the military's longitudinal clinical databases (Composite Health Care System - CHCS I and II) by searching for greater than expected associations of drug-event (or higher order combinations of drugs and events such as drug-drug-event or drug-event-event that cannot be explained by pair-wise associations where "event" is a categorized laboratory value, diagnostic procedure and/or sign or symptom or diagnosis=ICD9) in a large clinical longitudinal database. Potential confounding factors such as gender, age, ethnicity, geographic location, and calendar year should be controlled for by stratifying on these factors. In addition, methods for eliminating duplication of reports (consultant and primary physician or intern - resident - attending) need to be detected and eliminated. In addition the sequence of drug-first or event-first should be identified prior to analysis.

Adverse Drug Events (ADEs) are a type of iatrogenic injury occurring in both outpatients and inpatients. Identification of ADEs is an important first step in improving patient safety. Once an event is identified, systems can be in place to evaluate and assess them systematically. An adverse "event" due to a drug can be an abnormal laboratory value, diagnostic procedure, a sign or symptom, or diagnosis within the ICD, MedDRA, or SNOMED-CT coding systems. To detect an AE, one must have a standardized method of naming the event and then mapping the term to other terms used in other systems (eg., adverse events reported to the FDA are coded in MedDRA vs. patient charts use ICD9 coding). An ADE can describe simple relationships such as drug - event (cervistatin - rhabdomyolysis) or may describe complex relationships such as drug - concomitant drug - characteristic of a patient (e.g., gender, organ dysfunction, poor acetylator phenotype, deployment location) - event (abnormal lab value) - event (symptom). ADEs can be known, that is, the event was noted during drug development and is annotated in the drug label and can be part of a clinical information system (CIS) drug knowledge (e.g., First DataBank), or it can be unknown and not listed in the drug label or in the CIS.

Detection of a NEW ADE is difficult, especially if the event is rare and the etiology, frequency and pathology are uncertain. It is important to note that many ADEs may describe an event that (1) is a clinical syndrome that may be produced by several different drugs and non-drug causes, (2) is difficult in an individual patient to characterize and prove the causal role but the timing, dose, drug level, challenge and de-challenge data support the strength of association, and (3) may describe common entities (such as cough) or serious and rare events such as rhabdomyolysis.

The discovery of an ADE consists first of detection of a “safety signal”, then a hypothesis is generated and then the hypothesis is assessed. A safety signal is a difference in the occurrence of an event(s) or syndrome (combination of events) that cannot be explained by pair-wise associations in the population of users of a given drug (or drug class) or drug combinations and event. It is also any difference in the rate of reporting of an event in association with a drug relative to other drugs. Sources of signals primarily come from spontaneous reporting systems, such as the US Food and Drug Administration's (FDA) MedWatch program of Adverse Event Report System (AERS) and Spontaneous Reporting System (SRS) and anecdotal reports in professional journals. The AERS is a computerized database of drug adverse events reported by health professionals and others. The system contains only adverse events detected and reported after marketing of the drug for the time period indicated. The FDA has developed an empirical Bayesian data mining tool that systematically and objectively evaluates higher than expected associations by drug or by event, by drug combinations and syndromes in their AERS and SRS databases of MedWatch reports and then displays their results graphically.

Currently, the Department of Defense detects ADEs through a passive surveillance system of evaluating adverse drug events reported voluntarily by a physician. An active surveillance system would (1) decrease the time for signal-detection by increasing the rate of ADE reports, (2) rapidly generate new safety signals for our deployed soldiers using multiple drugs, thereby facilitating early investigations and appropriate risk management, and (3) permits rapid access by physicians to data on potential adverse drug reactions, serving as a reminder for the practicing physician or as a tool for ADE discovery. This project will also involve the development of complementary techniques using the longitudinal medical records to facilitate systematic analyses and independent validation of data mining signals. Linkage between the FDA signal outputs and the military data bases will help sort out signals difficult to discern from analyzing only a single database.

The Good Samaritan Regional Medical Center (Raschke et al 1998) developed a computerized alert system to prevent injury from ADEs. Their system was rule-based and successfully detected situations to prevent patient injury due to defined medications or procedures. Hadassah University Hospital (Levy et al 1999) developed an automatic laboratory signal system used for detection of safety signals. They also used a rule-based system defining lab values that signaled an alert for potential ADEs. Following their alert, the patient charts were reviewed by the research team. This study reported that almost 20% of their automatic laboratory signals were positive for an ADE that was not recognized by their staff physicians.

Our project includes the following technical challenges: mapping and collapsing the formulary drug name variations to standard drug names to map to same chemical entity; decoding the diagnosis (and signs and symptoms if using CHCSII), defining terms unlikely to represent an ADE; categorizing and mapping the laboratory code; generating overall summary statistics on the content of the database and providing a series of timelines and graphical summaries that display the longitudinal patterns of prescription, labs and diagnosis events; looking for safety signals by mining the database for "higher-than-expected" drug-event (lab or ICD-9) combinations using the temporal ordering (drug-first, event-second) to distinguish potential adverse reactions (diagnosis or abnormal lab follows drug); creating a method to eliminate redundant/duplicate records (multiple reports of same event) and spurious lab results. Test subset of charts selected with ADEs to determine false positive and false negative rates by method developed, compared to evaluation team review of charts vs. ADE signal reported by the FDA's data mining tool. Determine method to link ADEs detected with knowledge from other databases in order to serve as warning signal. Utilize CHCSII methods for start - stop drug and events and develop additional methods to validate. Data available: laboratory, diagnostic test and pharmacy data, ICD 9, geographic location, gender, age, allergies, race and calendar year. Additional data such as symptoms and signs, end-organ function, social history, allergy history, pertinent family history, nutritional status and patient adherence to prescribed regimen when medical chart fully electronic.

PHASE I: Design or modify a data mining tool (such as MGPS data mining method developed by DuMouchal in collaboration with the FDA) or propose application or modification of an existing one to accomplish the objective of data mining longitudinal clinical data from existing and evolving DOD health information systems (e.g. Composite Health Care System (CHCS) I and II; DOD clinical data repository), to detect adverse events AFTER use of a drug has been approved and is in the post-marketing surveillance phase. Develop screening algorithms/computer systems to efficiently signal higher-than-expected combinations of drugs and events in a longitudinal data base. Control for confounders such as age, gender, race, calendar year, and geographic(deployment) location. The objective of this SBIR topic presents a broad challenge in several different

areas of information processing technology. Because of the limited scope of an SBIR, project collaborators may choose to focus on only one or two of the challenges discussed above.

PHASE II Prototype and test a data mining tool design or modify and test an existing data mining tool. Implement and operationally test the tool in a real-world DOD Health System environment to demonstrate that it is effective in detecting adverse drug reactions. Coordinate development and testing with DOD and the FDA. Test randomly chosen medical charts reviewed manually vs. data mining tool vs. final results compared with data mining results obtained by FDA for reported events and drugs. The objective of this SBIR topic presents a broad challenge in several different areas of information processing technology. Because of the limited scope of an SBIR, those who submit a proposal may choose to focus on only one or two of the challenges discussed below. (69% of fatal ADEs are the result of CNS drugs, antineoplastic agents and cardiovascular drugs [Am J Health-Syst Pharm 2001;58:1317-24], a pilot trial could also focus in on these 3 drug categories).

1. Create a data mining workbench to support the investigation of data mining techniques as applied to longitudinal clinical data in CHCS.

2. Develop specific data preparation and transformation techniques (e.g., temporal abstraction to simplify the data analysis; eliminate problems with drug naming, duplication of events, spurious lab values, synonyms of drug names, coding of laboratory values, and symptoms. Develop system capable of mapping continuous, time-oriented clinical data and laboratory results to the kind of categorical information suitable for use with data mining techniques.

3. Develop techniques to map known adverse drug events (e.g., thrombocytopenia and heparin sodium use) present in CIS to safety signal detected by data mining. This will serve as a computer alert system that provides patient-specific information to clinicians with the specific aim of detecting the ADEs early, before harm occurs to the patient.

4. Develop technique to detect new safety signals (over represented drug-event entities in the clinical database) which would be the detection of early warning signs of a possible and newly described ADE.

5. Evaluate the ranked results (strength of signals, causal event-outcome event associations discovered by the software) against the hospitals database of spontaneous adverse event reports vs. a team reviewing the charts, vs. against the data mining output used by FDA with the assistance of medical staff at the FDA. Determine the relative strengths and weaknesses to guide the planning of a Phase II continuation of the project.

PHASE III. Implement the tool in DOD, VA and one or more civilian health care systems in conjunction with the FDA and a civilian drug manufacturing company or companies. Demonstrate ready exchange of data and data mining findings among the DOD, FDA, and participating pharmaceutical manufacturing company or companies.

REFERENCES:

1. DuMouchel W. Bayesian Data Mining in Large Frequency Tables, With an Application to the FDA Spontaneous Reporting System. *The American Statistical Association* 53(3):177-202.1999
2. O'Neill RT and Szarfman A. Some US Food and Drug Administration Perspectives on Data Mining for Pediatric Safety Assessment. *Curr Ther Res* 62(9) 650-663.2001
3. Munter KH, Schenk JF, Thrun F, Tladen JD, Wenzel E, and Muller-Oerlinghausen B. The "Phoenix" ADR Database of the Drug commission of the German Medical Profession- a Clinically Useful Approach to Optimize Evidence-Based Medicine in Germany. *Seminars in Thrombosis and Hemostasis* 23(1): 57-63. 1999.
4. Szarfman, A, Machado SG, O'Neill RT. Use of Screening Algorithms and Computer Systems to Efficiently Signal Higher-Than-Expected Combinations of Drugs and Events in the US FDA's Spontaneous Reports Database. *Drug Safety* 25(6).381-392. 2002.
5. Payne TH, Savarino J, Marshall R, Hoey CT. Use of A Clinical Event Monitor to Prevent and Detect Medication Errors. *AMIA 2000*: 640-644.
6. Bates et al. Incidence of Adverse Drug Events and Potential Adverse Drug Events. Implications for Prevention. *JAMA* 274(1) 29-34. 1995.
7. Gandhi TK, Seger DL, and Bates DW. Identifying Drug Safety Issues: From Research to Practice. *Int Soc Quality Health Care* 12(1): 69-76. 2000.

8. Tegeder I et al. Retrospective Analysis of the Frequency and Recognition of Adverse Drug Reaction by Means of Automatically Recorded Laboratory Signals. *Br J Clin Pharmacol* 47: 557-564. 1999.
 9. Niu MT, Erwin DE and Braun MM. Data Mining in the US Vaccine Adverse Event Reporting System (VAERS): Early Detection of Intussusception and Other Events After Rotavirus Vaccination. *Vaccine* 19: 4627-4634. 2001.
 10. Raschke RA, Golihare B, Wunderlich TA et al. A Computer Alert System to Prevent Injury From Adverse Drug Events. Development and Evaluation in a Community Hospital. *J Am Med Assoc* 1998; 280:1317-1320. 1998.
 11. Levy M, Azaz-Livshits T, Sadan B, et al. Computerized Surveillance of Adverse Drug Reactions in Hospital: Implementation. *Eur J Clin Pharmacol* 54: 887-892. 1999.
 12. Szarfman A et al. Use of Screening Algorithms and Computer Systems to Efficiently Signal Higher than Expected Combinations of Drugs and Events in the US FDA's Spontaneous Reports Database. *Drug Safety* 2002;25:381-392
 13. DuMouchel W Pregibon D. Empirical Bayesian Screening for Multi-Item Associations. *Proc of the Conference on Knowledge Discovery and Data*; 2001 Aug 26-29; San Diego, CA ACM Press; 67-76.
 14. Szarfman A. New Methods for Signal Detection . 15th International Conf on Pharmacoepidemiology 1999. URL:<http://www.fda.gov/cder/present/ispe-1999/ispe-ana.pdf>
 15. Levine JG Szarfman A. Standardized Data Structures and Visualization Tools: A Way to Accelerate the Regulatory Review of the Integrated Summary of Safety of New Drug Applications. *Biopharmaceutical Report* 1996;4(3) 12.
- Lazarou J, Pomeranz BH, Corey PN. Incidence of Adverse Drug Reactions in Hospitalized Patients. *JAMA* 1998;279:1200-5.

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