DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified 40 technical topics, numbered **DARPA SB962-045** through **DARPA SB962-084**, to which small businesses may respond in the second fiscal year (FY) 96 solicitation (96.2). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical offices.

DARPA Phase I awards are limited to **$99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor. Phase II proposals are encouraged at the amount of $375,000 with additional funding available for optional tasks. The entire Phase II effort should not exceed $750,000. The responsibility for implementing DARPA's SBIR Program rests with the Office of Administration and Small Business (OASB). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448
Home Page http://www.darpa.mil

The proposals will be processed by DARPA OASB and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the date of closing of this solicitation. Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1996 Phase I SBIR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Potential Post Applications ______

   i. Key Personnel ______

   j. Facilities/Equipment ______

   k. Consultant ______

   l. Prior, Current, or Pending Support ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Prior SBIR Awards ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. **Do not** use a cover. ______

   c. **Do not** use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

a. Original proposal, including signed **RED** Appendices A and B. ______
(Photocopies of **RED** forms will be accepted)

b. Four photocopies of original proposal, including signed Appendices A and B. ______

INDEX OF DARPA FY96.2 TOPICS

DARPA SB962-068Applications and Beamforming with Small, Wide-Band Elements

DARPA SB962-069Lightweight Electronically Steerable Antennas

DARPA SB962-070Micro Sensor Systems

DARPA SB962-071Innovative Missile Warhead Kill Mechanisms

DARPA SB962-072New Long-Range Air Target ID Techniques using RADAR

DARPA SB962-073Selective Energy Conversion into Mechanical or Electrical Power

DARPA SB962-074Kinematic Sensor/Sensory Environment and Multi-Axis Workstation Interface System for Synthetic Environment Operators

DARPA SB962-075Real-Time Closed-Loop Control of Variable Geometry Fluid Mechanical Surfaces

DARPA SB962-076Advanced Systems for Detecting and Localizing Mines or Submarines

DARPA SB962-077Low-Cost Miniature Active Radar Frequency (RF) Package

DARPA SB962-078High Speed Ships and Boats

DARPA SB962-079Supporting Technologies for Uninhabited Tactical Aircraft (UTA)

DARPA SB962-080Micro Unmanned Aerial Vehicle (UAV) System Design and Operation

DARPA SB962-081Micro Unmanned Aerial Vehicle (MUAV) Critical Technologies

DARPA SB962-082Modeling a Tip Vortex with Mass Injection

DARPA SB962-083Flexible Polymeric Waveguides for Optical Display Substrates

DARPA SB962-084Development of Novel Toners for Direct Printing of Conducting and Insulating Patterns

SUBJECT/WORD INDEX TO THE DARPA FY96.2 TOPICS

DARPA 96.2 TOPIC DESCRIPTIONS

DARPA SB962-045TITLE: Technologies for Field Detection of Explosives Associated with Unexploded Ordnance and/or Land Mines

CATEGORY: 6.2 Exploratory Development; Sensors, Environmental Quality

OBJECTIVE: Develop and demonstrate field-deployable technologies for real- or near real-time, chemically-specific detection of explosives at concentrations (or in quantities) relevant for the detection of unexploded ordnance and/or mines.

DESCRIPTION: Most technological approaches to detect unexploded ordnance and mines attempt to exploit physical properties associated with the ordnance items or mines, i.e., differences in the optical or electric properties, or the presence of small quantities of metal. However, there has been less focus on technologies that seek to detect the explosive material directly. This is partly because chemically-specific detection of low vapor-pressure explosive compounds is difficult. While laboratory analytical techniques permit highly sensitive, chemically specific analyses, these systems are large, not real-time, and require detailed knowledge on the part of the system operator. The Federal Aviation Administration has sponsored work in explosives detection, but systems resulting from these efforts are typically geared toward large, fixed operations. Recent advances in chemically-specific sensors such as surface acoustic wave technology, nuclear quadrapole resonance, immunoassay techniques, conducting polymer-based techniques, photoacoustic cells, ion mobility, and mass spectrometry, among others, may afford new opportunities for the detection of explosives in military applications.

PHASE I: Demonstrate chemically-specific detection of explosives (vapor or condensed phase) under laboratory conditions at field-level concentrations in the presence of common environmental interferants.

PHASE II: Using a prototype system, demonstrate detection of explosives under field-conditions and evaluate the probability of detection and false alarm rate.

COMMERCIAL POTENTIAL: Local law enforcement agencies and the aviation industry have a need for assessing threats posed by explosive materials. The ability to accomplish chemically-specific explosive detection with high probabilities of detection and low false alarm rates in a portable system will expand the commercial market for these systems. Also, portable systems can be used in environmental applications to determine the presence and level of explosive contamination real-time. This enhances the efficacy of cleanup processes.

REFERENCES:
1) *A Technical Assessment of Portable Explosives Vapor Detection Devices*, NIJ Report 300-89, Marc Nyden, 1990.
2) *Hidden Killers: The Global Land Mine Crisis*, Department of State, Bureau of Political-Military Affairs, December 1994.

DARPA SB962-046TITLE: Novel Sensor Development for Improved Process Control

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Creation of novel sensors and data analysis/fusion methodologies to enable the application of "Virtual Integrated Prototyping" (VIP) to advanced material processes.

DESCRIPTION: Research and develop innovative sensors for the monitoring and characterization of materials during processing which will generate the critical state information required as input into Intelligent Processing of Materials (IPM) models and control algorithms. Special emphasis should be on sensors or combinations of sensors which generate data related to the state of the material or component such as cure state, modulus, consolidation, dimensions, etc. Emphasis should also be on data analysis and fusion methodologies that permit critical parameters to be inferred from the measured data for cases where one cannot directly sense a parameter that the physical-chemical model indicates is critical to control of the process. Algorithmic innovation or application of recent advances in automatic target recognition, such as wavelet-based techniques for feature extraction and denoising, is of particular interest. An additional and broader application of this data will be to VIP, which refers to modeling and simulation-based prototyping of integrated process, sensing, and control systems, for industrial materials manufacturing applications critical to DoD.

PHASE I: Perform simulations or simple laboratory experiments to validate the sensor and/or data analysis/fusion methodology.

PHASE II: Create and validate the sensor and/or data analysis/fusion methodology on an application of interest to DoD. Complete documentation of test parameters and results must be delivered.

COMMERCIAL POTENTIAL: The creation of smart process control sensors will enable the more efficient development of advanced material processes of interest to DoD. As VIP becomes standard practice, these sensors will provide the underlying foundation for the control systems which will greatly reduce manufacturing costs and improve the quality of the components produced.

REFERENCES:

1) Wadley, H.N.G. and W.E. Eckhert, “Intelligent Processing of Materials for Design and Manufacturing,” J. Metals 41, 10 (1989).

2) Roy, Walter N. and Sean Walsh, eds., 41st Sagamore Army Materials Research Conference (Intelligent Processing of Materials), 29 Aug - 1 Sept 1994, H.N.G. Wadley, “Intelligent Processing of High Performance Materials,” pp. 57-94.

3) Laine, Andrew F. and Michael A. Unser, eds.Wavelet Applications in Signal and Image Processing II, Vol. 2303, 25-28 July, SPIE, 1994, Ronald R. Coifman and Naoki Saito, “Extraction of Features from Backgrounds.”

DARPA SB962-047TITLE: Self-Routing Optical Switching

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Electronics (Optoelectronics)

OBJECTIVE: Promote the development of optical signal switching technology that will enable the self-routing of signals in networks of sensors and other distributed communication nodes.

DESCRIPTION: Research leading to the development of self-routed, optical switching technology that will enable communication between a base station and nodes in a network with little or no power to actuate routing is sought. Candidate technologies for achieving such routing include wavelength selective add/drop multiplexing elements with tunable laser sources, optically active switches in which the presence of signal in the access fibers activates the switching function, or the application of non-linear elements that can be sequentially activated, possible with short optical pulses. Anticipated systems applications include very large networks with more than a hundred nodes.

PHASE I: Develop proof-of-concept design either through fabrication of prototype components, or by detailed modeling of designs based on demonstrated performance of existing components.

PHASE II: Develop and demonstrate a fully functional prototype capable of demonstrating critical functionality and provide design documentation for a full scale implementation.

COMMERCIAL POTENTIAL: The development of self-routing optical switches that require little or no local powering will enable large scale networks of optically addressable sensors.

REFERENCES: OSA Proc. on Photonics in Switching, Vol 16 (1993).

DARPA SB962-048TITLE: On-Chip Chemical Analysis

CATEGORY: 6.2 Exploratory Development; Environmental Quality, Chemical and Biological Defense, Sensors

OBJECTIVE: Develop integrated microsystems for on-chip chemical analyses.

DESCRIPTION: Components of many standard chemical processes have now been demonstrated at the level of the micromachined chip. The advantages to moving analyses on-chip include reduced sample and reagent volume requirements, reduced power requirements, the ability to perform multiple analyses simultaneously, and the ability to precisely control reaction chamber conditions. The greatest potential benefits of performing wet chemical manipulations in microfabricated environments, however, will come when multiple components and complete processes can be performed using fully integrated microsystems.

Proposers are asked to develop and prototype such integrated chemical processing microsystems. Depending on the particular application, a number of integrated microfluidic components will be required to store, transport, mix, and meter sub-microliter liquid quantities. Proposers are asked to detail current methods and instruments available to perform the proposed chemical analyses and to identify the specific advantages of performing the proposed chemical sequence at very small volumes in an integrated microsystem approach. Preference will be given to the development of microsystems to perform reaction and analyses sequences that either cannot be performed or cannot be adequately controlled at the macroscale. The target prototype microsystem should include both components and control in a single integrated package, although monolithic integration is not a requirement.

PHASE I: Develop proof-of-concept design. Identify and analyze the major problem areas associated with the proposed technology. Produce a development plan which addresses the approach to solving key technology issues. Identify quantitative goals for system performance.

PHASE II: Develop and demonstrate a fully functional prototype capable of demonstrating critical functionality. Provide design documentation for a full scale implementation. Explore critical parameters and optimize the design. Provide in-depth performance evaluation.

COMMERCIAL POTENTIAL: This technology will have commercial application in environmental monitoring, drug discovery and development, and physiological monitoring.

REFERENCES:
1) Harrison, D. J., Glavina, P.G., and Manz, A., "Toward Miniaturized Electrophoresis and Chemical Analysis Systems on Silicon: An Alternative to Chemical Sensors," Sensors and Actuators B, Vol. 10, 1993, pp. 107-116.
2) Fettinger, J.C., Manz, A., Ludi, H., and Widmer, H. M., "Stacked Modules for Micro Flow Systems in Chemical Analysis: Concept and Studies Using an Enlarged Model," Sensors and Actuators B, Vol. 17, 1993, pp. 19-25.
3) Van den Berg, A., and Bergveld, P. (eds.), Proceedings of Micro Total Analysis Systems Conference, Twente, Netherlands, Nov. 21-22, 1994.

DARPA SB962-049TITLE: Low-Cost, High Thermal Conductivity, Low Mass Density Electronic Packaging Materials

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Structures; Manufacturing Science and Technology

OBJECTIVE: Develop and demonstrate a low-cost, high thermal conductivity and low mass density material for use in electronic packaging. Target material characteristics are: cost less than aluminum heat sinks, thermal conductivity at least 200 W/mK, and mass density less than aluminum.

DESCRIPTION: Advances in integrated circuit manufacturing and innovations in design technologies are leading to new generations of wireless, portable information technology products. Size and weight, along with functionality, cost, and reliability are among the factors that differentiate these systems. A dual strategy of reduced power consumption and improved thermal management promises to greatly improve the performance capability of portable systems. In this project, thermal management materials are sought which perform better and cost less than those currently used in electronic products.

PHASE I: Provide a detailed technical plan that describes the specific material development approach and the anticipated material properties. Perform computer simulations, fabricate material samples, and measure material properties.

PHASE II: Implement the material development plan of Phase I. Perform extensive measurements to verify material properties. Demonstrate capabilities to produce the material at anticipated costs. Provide cost model of the material development process and transition plan for material commercialization.

COMMERCIAL POTENTIAL: Low-cost, light-weight, high thermal conductivity materials are critical to commercial electronic system OEM's. Applications such as laptop computer cases, convection cooled heat sinks for processors, and heat spreaders for wireless transmitters would benefit greatly from such a material.

DARPA SB962-050TITLE: Advanced Collection Management

CATEGORY: 6.2 Exploratory Development; Battlefield Awareness

OBJECTIVE: Develop algorithms and software to optimize and synchronize high-priority collection by multiple manned and autonomous assets subject to platform and sensor operational constraints.

DESCRIPTION: The addition of the Tier 2+ and Tier 3- Unmanned Autonomous Vehicles (UAVs) to current intelligence, surveillance and reconnaissance assets will provide unprecedented Battlefield Awareness to theater commanders. To fully realize the potential value of these platforms, algorithms and software are required to generate coordinated, multi-platform plans that ensure coverage of high priority targets while satisfying platform track (e.g., avoidance of air defense), sensor (e.g., viewing geometry) and other constraints. This represents an extremely complex problem, combining trajectory optimization, target-track assignment, scheduling and time-line optimization. New solution methodologies are sought for this problem to provide high quality plans and to reduce the timeline for plan generation to support dynamic sensor tasking.

PHASE I: Design a comprehensive solution approach. Prototype one or more of the key algorithms to demonstrate performance improvement versus heuristic approaches.

PHASE II: Develop a Joint Collection Management Tools (JCMT) compliant, rapid prototype implementation of the solution approach.

COMMERCIAL POTENTIAL: In addition to military applications, the algorithms and software developed would have significant application to scheduling and resource allocations in the manufacturing and transportation industries.

REFERENCES: Airborne Reconnaissance Technical Architecture Program Plan, Defense Airborne Reconnaissance Office, 1995.

DARPA SB962-051TITLE: Advanced Radio-Frequency Interference (RFI) Suppression Techniques for VHF-UHF Radar

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop innovative techniques for suppressing radio frequency interference in ultra-wideband synthetic aperture radars (SAR).

DESCRIPTION: Innovative methods and applications for the temporal, spectral or spatial cancellation of RFI in ultra-wideband (UWB) SAR images are sought. RFI may consist of many narrow-band sources such as UHF and VHF television, FM radio, cellular telephones, mobile radios, or a few localized wideband sources such as jammers or other radars. Develop innovative RFI suppression techniques that provide an improvement over current technology in terms of: improving the amount of RFI suppression, minimizing the effects upon the SAR impulse response function, or reducing the processing requirements for the same or better performance. Techniques that are suitable for demonstration and test with recorded data on high performance parallel processors are encouraged.

PHASE I: Define the application, algorithm and approach to suppressing RFI in UWB SAR imagery, and quantify the expected benefits through simulation.

PHASE II: Create a full implementation of the algorithm, and validate the performance using actual UWB SAR imagery. Complete documentation of the source code, test cases, and results must be delivered.

COMMERCIAL POTENTIAL: RFI in UWB SAR imagery is a major limiting factor in SAR performance. Efficient algorithms will increase the ability to perform land use planning, hydrology studies, earthquake analyses, and target detection. These areas are predicted to be of increasing interest by federal, state and local governments in the coming years.

REFERENCES: Giglio, D. A., "Algorithms for Synthetic Aperture Radar Imagery II," Proceedings of the International Society for Optical Engineering (SPIE), Orlando, Florida, 19-21 April 1995, pp. 71-129.

DARPA SB962-052TITLE: <u>Agile Modeling for In-Field Modification of Domain Information, Inference, and Knowledge Bases</u>

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Innovative approaches for adaptation and in-field modification of templates, models, and knowledge bases for automated target recognition (ATR), natural language processing (NLP), and fusion, correlation, and assessment.

DESCRIPTION: New methods are sought to maximize the flexibility of model-based and template-based computation supporting battlefield awareness, and to overcome the impediments to model-based information processing posed by: the large investments needed to construct those models, the difficulty in involving the user in building and understanding those models, and the fact that those investments need to be replicated for each new application, target set, or tactical environment. Agile modeling and templating solutions are desired in order to create broadly reusable tools, rather than on onetime builds of fragile models, so that the user is the one responsible for maintaining their own picture of how the battlefield works. These methods may include learning techniques based on incoming observations as well as user-directed modifications based on evolving tactical or strategic situations. Template-based techniques would use data gathered from new targets from limited looks to build templates to support ATR algorithms. Applications should be directed toward capabilities including intuitive user interfaces, model construction and sharing based on generic ontologies or model fragment libraries, and automated updates to executable code. Techniques that exploit current leading edge technology in both knowledge-based (rules, schemata, first-order logic, etc.) and stochastic (Bayes nets, fuzzy logic, etc.) models and inference, including modeling techniques for unifying those approaches, are all encouraged.

PHASE I: Define theoretical approaches, apply concepts to limited problem sets, or explore a more generalized application of existing techniques.

PHASE II: Create a full implementation of templating, modeling, algorithmic, or user-interface techniques. Incorporate into existing model-based systems and deliver complete documentation of source code, test cases, and results.

COMMERCIAL POTENTIAL: The flexibility and reuse of domain information and knowledge bases are major limiting factors in the application of model-based information processing systems. Agile modeling techniques are predicted to have significant impact on the spread of such systems for remote sensing, language-based observation, and evidential reasoning applications, through an increase in the utility and reusability of core systems and in user access to, and control of, the adaptations made for particular applications.

REFERENCES:
1) R. Lopez de Mantaras and D. Poole, eds., Proc. Uncertainty in Artificial Intelligence, Morgan Kaufmann, San Francisco, 1994, pp. 262-69, 440-46.
2) R. Neches, et al., "Enabling technology for knowledge sharing", AI Magazine, 12(3), 1991, pp. 16-36.

DARPA SB962-053TITLE: Simulating Human Behavior for C3I, Planning, and Battlefield Awareness

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Create realistic Artificial Intelligence technologies to accurately represent human decision making for simulated C3I, Planning, and Battlefield Awareness systems.

DESCRIPTION: DARPA is seeking an integrated solution to providing dominant battlefield awareness. Simulation represents one method of investigating issues relative to this comprehensive view. Current representations of human behavior in simulation are still rudimentary, based largely on finite state machines or simple rule sets. DARPA is seeking advanced technologies which will allow improved representations of human decision making on the battlefield at a reasonable computational cost. The resultant computer generated forces must run much faster than real-time and at high echelons of command (Army Brigade and above, or equivalent). In addition, the full range of appropriate staff functions to support C3I, Joint Task Force Planning, and Battlefield Awareness, such as analysis, fusion, evaluation, dissemination, decision making, and execution should be addressed. Solving this requirement is fundamental to the improvement of simulation throughout DoD.

PHASE I: Design and Execution Plan for a Prototype of Human Behavior in Computer Generated Forces.

PHASE II: Instantiation of Prototype in a Service/Intell agency specific mission area.

COMMERCIAL POTENTIAL: There is significant potential within civilian industry, particularly the entertainment industry, for the use of this technology.

REFERENCES:

1) Marshall, C. And Garrett, R. “Simulation for C4ISR: Command, Control, Communications, Computers, Intelligence, Surveillance, & Reconnaissance,” Phalanx, March, 1996.

2) Hayes-Roth, B. “On Building Integrated Cognitive Agents: A Review of Allen Newell’s Unified Theories of Cognition.” Artificial Intelligence 59:329-341. 1993.

3) Laird, J.E.; Jones, R.M.; and Nielsen, P.E. “Coordinated Behavior of Computer Generated Forces in TacAir-Soar.” In the Proceedings of the Fourth Conference on Computer-Generated Forces and Behavioral Representation, 325-332/ Orlando, Fla.: University of Central Florida Institute for Simulation and Training, 1994.

4) Nelson, G.; Lehman, J.F.; and John, B.E. “Integrating Cognitive Capabilities in a Real-Time Task.” In Proceedings of the Sixteenth Annual Conference of the Cognitive Science Society. Hillsdale, N.J.: Lawrence Erlbaum. 1994.

DARPA SB962-054TITLE: Battlefield Dynamic Databases

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Innovative methodologies for implementing dynamic databases based on real-world data in simulation, or based on evidential and knowledge-based reasoning.

DESCRIPTION: The extraction of appropriate information from the vast amounts of data being collected by current and next generation sensor systems should lead to a better understanding of the battlefield. Two alternative approaches promise to enable the filtering, abstraction and integration of relevant information from this sea of data:

(1) Simulation. Because battlefield simulations provide a higher level abstraction or "view" of the battlefield, simulation models should provide a means of transforming battlefield data into battlefield information in a context most relevant to the commander. Coupling a battlefield dynamic database with a large scale simulation should support higher levels of fusion as well as advanced Intelligence Preparation of the Battlefield, Battle Damage Assessment, and After Action Analysis and Review. The resultant computer generated forces must run much faster than real-time at a reasonable computational cost.

(2) Evidential and Knowledge-Based Reasoning. Detecting relevant features, objects, targets, military units, strategic movements, etc., in the vast amounts of available sensor data may benefit from a hybrid reasoning strategy which mixes

probabilistic approaches to evidential reasoning, such as Bayesian inference, with more symbolic, logic-based approaches to knowledge-based reasoning. This hybrid approach could enable the use and integration of multiple reasoning strategies, at different levels of abstraction, resulting in the more accurate interpretation of sensor data at all levels of the feature-object-target-unit hierarchy.

PHASE I: Define the system approach, the limits of scalability, and quantify the expected benefits achievable through simulation or evidential and knowledge-based reasoning.

PHASE II: Create a prototype system that demonstrates the concept and evaluates either: the hypothesis that simulation view of the battlefield can be used to aid in the transformation of battlefield data into battlefield information for the commander, or the hypothesis that a hybrid evidential and knowledge-based reasoning approach could be used to interpret and transform sensor data more accurately into battlefield information for the commander. Complete documentation of experimental methodology, test cases, and results must be delivered.

COMMERCIAL POTENTIAL: The development of an efficient mechanism for using real-world information as the basis for simulations could dramatically reduce the cost of using simulations for such things as disaster preparedness, and emergency management.

REFERENCE: "Simulation Data and the Need for Standardization," Phalanx, December 1995.

DARPA SB962-055TITLE: Rapidly Mapping Real Environment Changes to Synthetic Environments

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Design and implement technological approaches to rapidly create and realistically distribute terrain information.

DESCRIPTION: Mission rehearsal and intelligence preparation of the battlefield are a primary mission for both Battlefield Awareness and simulation. Accurate, current, and realistic representation of the environment digitally is challenging. Although some research is being conducted in introducing dynamic changes to the synthetic environment, of particular interest is mapping real-world environmental changes to the synthetic environments. For mission rehearsal purposes it would be extremely valuable to be able to quickly map changes, such as blown-out bridges, into the terrain database without having to recreate the database.

PHASE I: In detail, define a technical approach which will lead to a Phase II demonstration of a techniques) for solving the rapid transformation of real-world environmental data into digital representations capable of being used in a simulation environment.

PHASE II: Demonstrate a tool that embodies principle technical solutions to rapid insertion of real-world data into synthetic environments. The demonstration should focus on an implementation under the current DoD High Level Simulation Architecture for modeling and simulation. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: The development of computationally-efficient and cost-effective means of dynamically changing synthetic environmental representations would have broad ranging applications from emergency disaster preparedness to agricultural crop and environmental impact analysis.

REFERENCES:
1) An Introduction to the High Level Architecture (HLA) Runtime Infrastructure (RTI); Calvin, Weatherly, Mar 1996 DIS Conference paper.
2) The DoD High Level Architecture and the Next Generation of DIS; Miller, Mar 1996 DIS Conference paper.

DARPA SB962-056TITLE: Three-Dimensional (3-D) Modeling by Videotaping

CATEGORY: 6.2 Exploratory Development; Computers and Software

OBJECTIVE: Design and demonstrate techniques to reconstruct 3-D scene and object structure from an image sequence, taken freely by an ordinary video camera.

DESCRIPTION: Automatic acquisition of 3-D models of buildings, vehicles, and structures is in high demand for visualization and mission-rehearsal systems. However, manual construction of such models takes far too long to be of practical use, and interferometric synthetic aperture radar (IFSAR) and overhead imagery are too scarce for many applications (and don't offer a complete solution).

The structure-from-motion problem has been long studied and much is known about 3-D constraints derivable from sequences of images in which point correspondences can be established. The processing power of commodity computers is now reaching the point where it may be possible to develop practical 3-D modeling applications that exploit these results. Potential military applications of this technology include: automatic construction of detailed terrain models from airborne video cameras; automatic construction of 3-D models of building exteriors and interiors from hand-held video; rapid acquisition of 3-D models of vehicles for use in visualization systems.

PHASE I: Design and prototype key components of system to be built in Phase II. Evaluate accuracy, reliability, and flexibility attainable. Finalize design of complete system.

PHASE II: Build, demonstrate, and validate complete system.

COMMERCIAL POTENTIAL: The development of computationally efficient, low-cost modeling techniques using video cameras has a ready market in such diverse applications as model capture for computer graphics and visualization of properties in real estate and construction. Potentially, the ability to rapidly produce 3-D models by videotaping could spawn a new genre of consumer products for home use.

REFERENCES: Proceedings, ARPA Image Understanding Workshop, Palm Springs, California, February 12-15, 1996. Available from: Morgan Kaufmann ($50).

DARPA SB962-057TITLE: Next Generation Automated Target Recognition (ATR) Algorithms and Automatic Target Detection and Terrain Mapping with Foliage-Penetrating (FOPEN) Radar

CATEGORY: 6.2 Exploratory Development; Sensors

ATR OBJECTIVE: Create efficient computer algorithms to exploit higher dimension ATR attributes such as polarization, absolute intensity, and multi-kernel images to increase ATR performance.

FOPEN OBJECTIVE: Create efficient computer algorithms to detect manmade objects, and/or perform radar mapping of the terrain, below the tree canopy.

ATR DESCRIPTION: In order to meet military commanders' information needs, ATR systems must exploit available target observables. Many of today's ATR algorithms are based on a two-dimensional scene representation. By exploiting higher dimension ATR attributes, the ATR performance is improved. Some of the unexploited observables are polarization, absolute RCS intensity, and multi-kernel images. By using the available target polarization, preferential target scattering centers provide information useful in target classification and identification. Absolute versus relative intensity is used in a similar way to exploit known target RCS values and variations. Finally, multi-kernel images provide a vector for each two-dimensional pixel that contains the various attributes used for ATR exploitation.

FOPEN DESCRIPTION: Innovative methods and applications for the problems of detection of manmade objects and radar mapping of the terrain surface under vegetation coverage are sought. Develop algorithms to automatically process and detect features using ultra-wideband (UWB) FOPEN synthetic aperture radar (SAR) imagery consistent with high throughput, parallel processors. Make use of any or all of the following: change detection, image-recognition and contextual information, polarization signature, high-resolution spatial-spectral signature, and interferometric height measurements based on the physics of microwave interaction with the foliage canopy. Techniques that are capable of dealing with incomplete or corrupted data are required.

PHASE I: Define the applications, algorithms, and approaches to exploit features using next generation ATR algorithms and UWB SAR imagery, and quantify the expected benefits through simulation.

PHASE II: Create an implementation of the algorithms, and validate the performance using actual SAR imagery. Complete documentation of the source code, test cases, and results must be delivered.

ATR COMMERCIAL POTENTIAL: The development of automated ATR applications will increase one's ability to perform many environmental and disaster relief tasks not currently possible. This research area is of current interest by federal, state, and local governments, and the needs are expected to increase in the coming years.

FOPEN COMMERCIAL POTENTIAL: The development of efficient automated methods to detect objects under the trees and to perform sub-foliage mapping will increase the ability to perform land use planning, hydrology studies, earthquake analyses, and target detection. These areas are predicted to be of increasing interest by federal, state and local governments in the coming years.

REFERENCES:
1. Fleischman et al, "Foliage Penetration Experiment, Parts I-III," IEEE Transactions on Aerospace and Electronic Systems, January 1996, Volume 32, Number 1, pp. 134-166.
2. Giglio, D. A., "Algorithms for Synthetic Aperture Radar Imagery II," Proceedings of the International Society for Optical Engineering (SPIE), Orlando, Florida, 19-21 April 1995, Session 8, SAR Topographic Mapping, pp. 371-401.

DARPA SB962-058 TITLE: Synchronous Collaboration Glueware, Tools, and Metrics

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop software (glueware), tools, environments that enable several or more users to simultaneously and seamlessly view, share, and update documents regardless of which hardware, operating system, or application was used to create the original document. Develop metrics and related test probes and analysis tools, benchmarks, and other measurement approaches to quantitatively and qualitatively evaluate and certify real-time videoconferencing and personal conferencing systems and services.

DESCRIPTION: Development of software (glueware), tools, environments that enable at least three users on different clients and operating systems using different commercially-available word processing, presentation authoring, and/or spreadsheet applications to see each other and rapidly interconnect these applications to simultaneously view and update a "shared" object. This "shared" object would be a multimedia-based document, presentation, or spreadsheet with a look and feel provided to each user that appears like their native application or can be toggled to provide all collaborating users with a seamless, integrated view of the shared object. For example, user A using AmiPro on a PC running Windows, user B using Microsoft Word on a Macintosh running MacOS, and user C using WordPerfect on a Sun running Solaris can synchronously collaborate on a complex word processing document embedded with pictures, graphs, and tables. This objective also includes the development of metrics and related test probes and analysis tools, benchmarks, and other measurement approaches to quantitatively and qualitatively evaluate and certify real-time videoconferencing and personal conferencing systems and services.

PHASE I: Survey commercial collaboration products and services and business function software. Select a subset of products and services to interconnect and perform synchronous collaboration and with which to focus test measurement and analysis techniques. Define in detail an approach to achieve the objective. Prototype initial implementation and evaluate using defined criteria. Establish productization/business plan.

PHASE II: Create the full implementation of a tool/environment that embodies the Phase I software and approach. Validate performance/usability by evaluating selected commercial systems and services in a command and control, engineering design, or business office scenario. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: Research to rapidly compose instantiations of collaboration between individuals, between people and systems, and between systems is well underway. Commercial videoconferencing and personal conferencing products and services are currently being developed and marketed. The usability of research results and commercial componentware is dependent upon its perceived and documented value. Disciplined test metrics, measurement, analysis, and certification will allow this research to prosper, accelerate bringing ideas to market, improve the quality and usefulness of collaboration products and services, and provide consumers with the ability to make informed choices. This research will accelerate the access and usability of multiple collaboration paradigms by allowing the use of legacy business function software applications. The ability to conduct synchronous collaborations between individuals consistent with their own native legacy functionality will buy down additional learning curves and more quickly empower groups to be more collaborative and productive.

DARPA SB962-059 TITLE: System Synthesis Environment

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Design and develop automated and visual aids to assist systems engineers in the development of complex systems.

DESCRIPTION: The instantiation of the very complex systems being designed as a result of the push to COTS technology has very much become a "system synthesis" approach. That is, there are given technologies, COTS based, consisting of communication, input/output (I/O) as well as computational resources that must be orchestrated into a system capable of meeting a given set of requirements that often include real-time and embeddable constraints.

As a result of this system synthesis, the opportunity exists to develop an environment to support systems engineers in the definition of their system. Such an environment would be populated with a database of existing components or components being considered. It would also capture sufficient algorithmic, I/O, operating system, and behavioral information to enable the system engineer to select the various resources and design the "best" system solution in response to the given set of requirements.

The environment should be capable of performing sufficient performance analysis to enable an architecture assessment of sufficient fidelity and quality so that a determination of "goodness of fit" of the proposed synthesized system is possible. Approaches that automate as much of the process as possible and provide aids to the system engineer (modeling, heuristics, visualization, automated processing, real-time aspects, etc.) would be most attractive. The environment must be capable of representing the system at various levels of detail and supporting various views of the system. For example, not only should the environment provide a wiring diagram, but also a view of the software architecture or a parts list or sufficient information to enable a reliability analysis to be conducted. Finally, the environment should be "open" to allow for the inclusion of other tools in a "plug and play" fashion (e.g., a tool that might support a visualization of the modeled system).

PHASE I: The report delivered at the end of Phase I should clearly define the environment proposed and address the user interface that will be employed by the system engineer. The report should define how the environment will be applied in Phase II, how databases will be populated and maintained and how the environment will be validated, and discuss the "openness" of the proposed solution.

PHASE II: The proposed environment should be developed and applied to a military or commercial application. Significant test data should be gathered and reported against actually developed systems to validate the environment and assess its completeness. Plans for commercialization of the approach and availability to DoD should be developed in Phase II.

COMMERCIAL POTENTIAL: There is a growing demand for aids when confronted with the increasingly complex systems required by today's high performance demands in both the industrial and military sectors. The data base portion of the environment, if properly maintained, as well as the aids provided to the systems engineer, will enable the more rapid development of systems as well as provide mechanisms to address "what if" analysis. The increased military use of COTS, which is also shared by the industrial community, will provide for use by both markets.

REFERENCES:
1) World Wide Web DARPA/ITO Home Page, URL http://www.ito.darpa.mil
2) The High Performance Computing and Communications "Blue Book" for 1995 and 1996, URL http://www.hpcc.gov

DARPA SB962-060TITLE: Model Neutral Data Representation

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Define and develop a mechanism to enable interoperability of differing model representations.

DESCRIPTION: Modeling of systems has increasingly become the method of choice when attempting to understand, characterize, or analyze the very complex systems being built today to solve military problems.

Models that attempt to represent hardware performance, software performance, input/output, and various communication attributes (e.g., protocols, latency, throughput, etc.) in addition to thermal and reliability analysis are examples of where models with different views are being successfully incorporated. However, many of these models require common information and would benefit from the seamless capture of the information provided by another model (e.g., reliability analysis might require thermal analysis results). What is required is a data structure and access mechanisms available to each model to enable the model to obtain common information which may also be used by the model to provide data that might be utilized by other modeling views and/or methodologies.

Such a representation is a data middleware that would provide a "plug and play" capability for new models being developed as well as obviate the requirement to provide translators between all possible model views.

Successful solutions will be able to take several representations of a system—e.g. a performance model and a thermal analysis model—and enable each representation to access the canonical data structure to obtain the requisite information required by it. Visualization mechanisms that support these various views are also of interest. For example, the model neutral representation should support a discrete event simulation as well as a Petri-net simulation and provide visualization techniques consistent with the solution domain of the user.

PHASE I: The report delivered at the end of Phase I should clearly define the data structures proposed and should address the access mechanism that will provide for the seamless integration of models. The report should define how the data structures and access mechanisms will be applied in Phase II, what metrics will be used to measure the degree of interoperability, and how models will use the mechanisms. The report should also discuss the "openness" of the proposed solution.

PHASE II: Proposed data structures and mechanisms should be developed and applied to a collection of modeling methodologies to demonstrate the interoperability of the approach. For example, demonstrations using Petri-net based models, discrete event simulation, and thermal models using the data structures would be of interest. Significant test data should be gathered and reported against the metrics proposed to validate the assumptions on actual applications of interest to defense. Plans for commercialization of the approach and availability to defense should be developed in Phase II.

COMMERCIAL POTENTIAL: There is a growing demand for modeling of systems in industrial and military applications. Typically, various models need to be executed in order to extract the requisite information. The ability to share common data will significantly reduce the time required to develop and increase confidence in the models as any model assumptions are centralized. Many of the modeling techniques are common between defense applications and commercial applications and both markets wish to use the same technology base.

REFERENCES:
1) World Wide Web DARPA/ITO Home Page, URL http://www.ito.darpa.mil
2) The High Performance Computing and Communications "Blue Book" for 1995 and 1996, URL http://www.hpcc.gov

DARPA SB962-061TITLE: Novel Approaches to Creating Fault Tolerant, Scalable, Heterogeneous Computing Systems for Defense Applications from Components Not Necessarily Designed to be Fault Tolerant

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop and demonstrate novel approaches to creating scalable, heterogeneous, fault tolerant computing systems for defense applications comprised of components that are not necessarily designed to be fault tolerant (e.g. COTS).

DESCRIPTION: Fault tolerant embedded systems with high availability and data integrity have always been central to core DoD applications where loss of information or control can seriously damage the success of a mission. Applications include aerospace, telecommunications and real-time command and control. The rapid increase in automation and computer control in all areas of decision-making means that traditional fault tolerant solutions based on slow or outdated technology which incur long lead times for design and validation are no longer viable. New methods that incorporate fault tolerance features from the early design stage, and include rapid error detection and recovery from the hardware, software, and application perspective—keeping in mind real-time constraints—are essential. The issues of networking of heterogeneous components and their scalability must also be addressed. Importantly, testing and validation of the system against a wide range of adverse conditions and with a high degree of confidence must be ensured.

New and novel approaches to fault tolerant computing have not been developed. Increased use of scalable, heterogeneous high performance computing systems, both parallel and distributed, consisting of general purpose processors, digital signal processors, Field Programmable Gate Arrays (FPGAs), and Application-Specific Integrated Circuits (ASICs) connected by one or more communication fabrics attached to a collection of sensors demand new and innovative approaches to fault tolerant computing.

Proposals are sought in the area of scalable, heterogeneous, fault tolerant systems in the context of a "complete system solution." In particular, what is required at the chip level, the multi-chip level, the board level and the system level in the communication, memory and storage components, as well as operating system/kernel support, to enable the transparent, robust and cost-effective development and deployment of fault tolerant systems in a scalable, heterogeneous embedded environment? Some specific issues to be addressed include: the ability to test, diagnose, and repair manufacturing and operational faults; issues of providing software and network fault tolerance; and the development of hardware and/or software environments for validation of new designs incorporating new technologies in real-time operational conditions. Solutions must address the increased use of COTS components by the military community. That is, how to build fault tolerant systems when working with components that were themselves not designed to be fault tolerant. Solutions that address the incorporation of these fault tolerant solutions into legacy systems are also of interest.

Solutions should be non-intrusive and may be hardware or software based. Because of the real-time nature of the systems, the solutions must be sensitive to low latency requirements.

Also of interest is the definition, development, evaluation, and validation of a fault tolerant measure, recognizable by the general community, that may be used to not only compare/contrast various fault tolerant implementations, but can also be used in a system specification.

PHASE I: The report delivered at the end of Phase I should clearly define the fault tolerance techniques proposed and should address the concerns expressed above including the non-invasive application to scalable heterogeneous computing systems. The report should define how the fault tolerant techniques will be applied in Phase II, what metrics will be used to measure the degree of fault tolerance, and what guarantees can be made about the resulting system-level fault tolerance for various degrees of fault tolerant system components.

PHASE II: Proposed fault tolerance techniques should be developed and applied to a heterogeneous scalable system to demonstrate the fault tolerance approach. Significant test data should be gathered and reported against the metrics proposed to validate the assumptions on actual applications of interest to DoD. Plans for commercialization of the approach and availability to DoD should be developed in Phase II.

COMMERCIAL POTENTIAL: There is a growing demand for fault tolerant systems in industrial and medical application areas to be comprised of heterogeneous off-the-shelf components. These components will not be designed with fault tolerance attributes but must be combined to produce a fault tolerant system. Many of the fault tolerant characteristics are common between defense applications and commercial applications and both markets wish to use the same technology base.

REFERENCES:
1) World Wide Web DARPA/ITO Home Page, URL http://www.ito.darpa.mil
2) The High Performance Computing and Communications "Blue Book" for 1995 and 1996, URL http://www.hpcc.gov

DARPA SB962-062TITLE: Semantically-Based User Interface Management Tools for Dynamic Languages and Mobile Code

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop a high level toolkit appropriate for use with emerging dynamic languages and mobile code systems (e.g. Dylan, Lisp, Java, Smalltalk) which allows the interface between a program and its users to be expressed in high level terms appropriate to the semantics of the program.

DESCRIPTION: Research and develop tools which will dramatically raise the level of abstraction at which Human Computer Interaction is managed. Today's systems are still largely concerned with the low level details of screen management and do not provide seamless integration between the interface and the semantics of the program. The toolkit developed should provide extensible interfaces to existing User Interface toolkits and should establish a framework within which it will be possible to transform existing program interfaces to exploit future interfaces technology using speech, natural language, and visual recognition. Efforts should be situated in the context of advanced high level dynamic languages and/or mobile code systems (e.g. Smalltalk, Dylan, Java, Lisp, etc.).

PHASE I: In detail, define the framework, its protocols and layering structure, its techniques for interfacing to lower level toolkit, and its method of relating program semantics to interface presentation.

PHASE II: Create an implementation of a tool that embodies the design developed in Phase I. Demonstrate its ability to operate in a highly dynamic environment with adequate performance. Outline and document the techniques for mating the toolkit with other underlying frameworks and evolving its functionality as new interface technologies become available.

COMMERCIAL POTENTIAL: The market for mobile code systems use to provide high level interfaces within the World Wide Web is beginning to grow dramatically; Java (from Sun) represents an early attempt to provide tools for this environment. However, as yet this is a very low level framework with few, if any, design tools. Dynamic languages (e.g. Java, Lisp, Smalltalk, Dylan) are perceived as the obvious languages for developing such applications; the established members of this family have a longstanding, committed niche market in the Artificial Intelligence and financial communities. These provide a natural early market for the technology.

DARPA SB962-063TITLE: Design Rationale Capture

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop a software development environment integrating the capture of design rationale into the normal collaborative discussions among a team of designers.

DESCRIPTION: Design rationale includes descriptions of how a system is structured, why it is structured that way, and how it evolved to its current form. Without knowledge of what things exist and why they exist the way they do, a system upgrade team is left with little more than "system archeology" to guide their actions.

To date, most design rationale is lost because: 1) designers are forced to use specialized, formal notations to express design rationale; 2) they are forced to step outside of their normal workflow in order to enter design rationale; and 3) tools do not exist to retrieve appropriate elements of the rationale in convenient ways.

The keys to effective rationale capture are to capture the information at the time it is generated, with as little burden on the originating design team's time as possible (preferably none), and with little or no impact on the way the design team works. The uses of speech recognition and natural language based retrieval technologies are possible points of leverage in realizing these goals. Similarly the use of a large software design knowledge base may make rationale capture simpler by allowing developers to refer to things the system already knows, rather than having to create lengthy descriptions.

The environment developed should address any of the following:

(1) *Integration with Collaboration Tools*: Integrating rationale capture into a framework of electronically mediated group collaboration tools so that interesting elements of design discussions can be captured and indexed with little additional guidance from the users. The collaboration environment should be based on E-mail, the World Wide Web, desktop video conferencing, or other technologies which will form the normal communication environment for cutting-edge researchers in the next few years.

(2) *Full Text Natural Language (NL) Based Retrieval*: Using full text and/or natural language based retrieval tools to facilitate indexing and retrieval.

(3) *Software Design Knowledge Base*: A broad coverage knowledge of standard, abstract software structures and transformations to which designers may easily refer.

Rationale should be captured and stored in a design web which highlights key relationships among the various artifacts comprising the product.

PHASE I: In detail, define the techniques to be employed and the tools to be used in effecting these techniques. For (1) *Integration with Collaboration Tools,* define the collaboration environment and the extra interactions required by the users to cause rationale elements to be captured. For (2)*Text and NL Based Retrieval*, define the retrieval tools to be used and assess their coverage. For (3)*Software Design Knowledge Base,* define at least the top levels of the taxonomy of structures and transformations.

PHASE II: Create a prototype implementation of the environment defined in Phase I. Demonstrate its ability to handle rationale discussions about systems of modest complexity. Outline techniques for extending the system and scaling it to handle systems of greater complexity.

COMMERCIAL POTENTIAL: Rationale capture is one of the key points of leverage in managing the evolution of complex systems. Increasingly, software is not being created de novo but rather is built by modifying or extending existing components to meet new needs. Software developers are facing the task of maintaining large-scale, complex systems for decades in an environment where contributors do not stay on the project for more than a few years. Organizations managing such projects have recognized the need to capture and manage design rationale, but they cannot today find practical tools for the task. A development environment which seamlessly captures design rationale will therefore meet a receptive audience. This capability is particularly critical to building evolvable defense software systems.

DARPA SB962-064TITLE: <u>Stabilization of Diode Laser Arrays</u>

CATEGORY: 6.3 Advanced Development; Materials, Processes and Structures

OBJECTIVE: Develop active control to stabilize diode laser arrays against chaotic oscillations. Stabilized arrays can operate at higher gain and at higher packing densities.

DESCRIPTION: Diode laser arrays are known to become unstable under conditions of high gain and/or high packing density in integrated structures. Chaotic oscillations occur in these systems due to the nonlinearity of the diode laser and coupling between elements in the array. Currently this type of instability is the primary barrier to producing high density and high gain arrays in integrated optical devices. Recently it has been demonstrated that chaotic oscillations can be controlled by small, but intelligent, perturbations to the state of the system or to an accessible parameter governing the dynamics. Therefore, it is highly probable that spacial instabilities such as those in diode laser arrays can also be controlled by perturbing a single element or the elements along a single edge of the array.

PHASE I: Simulate a diode laser array with electronic elements. This electronic testbed would require data acquisition regarding the state of the array. In addition, it would be necessary to modify the parameters governing one or more elements of the array in real-time in response to an external control signal. The external signal would be provided by a programmable device capable of simulating different control algorithms. This testbed is intended to be delivered to Weapons Sciences Directorate (WSD) for use as a facility for continuing research and testing in spacio-temporal chaos control of interest to RDEC. Expertise would be available from WSD for designing chaos control algorithms.

PHASE II: Fabricate a diode laser array. Provisions would be made for an external control signal to effect stabilization via the control algorithm chosen in Phase I. A demonstration would show the controlled diode laser array to be stable at high gain and packing density significantly beyond the limit of uncontrolled arrays.

COMMERCIAL POTENTIAL: This work will contribute to all areas both military and commercial where laser diodes are utilized and in particular where additional power and stability is needed. Stabilized arrays can operate at higher gain and at higher packing densities than otherwise possible.

REFERENCES:

1) Ott E., C. Grebogi, and J.A. Yorke, “Controlling Chaos,” Phys. Rev. Lett. 64: 1196-1199, 1990.

2) Winful H., “Instability Threshold for an Array of Coupled Semiconductor Lasers,” Phys. Rev. A, Vol 46, No. 9, 6093-6094:1992.

DARPA SB962-065TITLE: Photonic Systems for Tunable True Time-Delay

CATEGORY: 6.2 Exploratory Development; Electronics

OBJECTIVE: Provide a true time-delay device for large tunable delays of short and ultrashort optical pulses in a compact structure that exhibits very low loss. Pulse distortion should also be largely absent.

DESCRIPTION: A novel photonic system is sought to provide true time-delay transmission paths for arrayed microwave signals. The envisioned system will consist of a robust electrically-controlled photonic delay device for operation in the near- to mid-infrared (approximately 1.5 micron wavelength) and will be capable of operating in the gigahertz regime, with operating voltages consistent with those used in TTL logic. The optimum design will maximize performance versus size (large delay produced by a device with minimal dimensions). Minimal distortion of optical pulses in combination with large tunable delay and very low loss is crucial to expected device performance. It is expected that a large number of devices, each of which may exhibit smaller tunable delays, may be serially addressed in order to realize a large tunable delay. A robust material, such as semiconductor, is expected for use in the device design, so that the device may suitably be incorporated in an integrated circuit environment. In short, a design that is compatible with an information handling environment based on digitized short and ultrashort optical pulses is sought. In addition, an in-depth experimental exploration of a family of devices is expected, along with an evaluation of the performance of different structures with regard to the following parameters: sensitivity of delay to controlling electrical signal, distortion of optical pulses under delay operation, and transmission loss of device.

PHASE I: Characterize materials and designs for use in devices. A feasible design of an optimum prototype structure is expected. Evaluate relation of devices to Army needs and applications.

PHASE II: Build and experimentally test prototype structure and evaluate performance of operating device. Report on feasibility of building micro-array of individually-addressed devices integrated on microchip for use in optically controlled phased-array radar. Provide report on manner in which such a device will fit into existing Army technology and future Army systems.

PHASE III: Demonstrate incorporation of micro-array device in a small system. Show ability to control an actual system in which true time-delay is required. Evaluate transitioning to Army applications such as agile phased array radar and optically controlled beam steering. Show capacity to synchronize optical devices operating in gigahertz regime.

COMMERCIAL POTENTIAL: This work will contribute to all areas both military and commercial where a novel photonic system can provide true time-delay transmission paths for arrayed microwave signals. The envisioned system will consist of a robust electrically-controlled photonic delay device for operation in the near- to mid-infrared (approximately 1.5 micron wavelength) and will be capable of operating in the gigahertz regime, with operating voltages consistent with those used in TTL logic. The optimum design will maximize performance versus size (large delay produced by a device with minimal dimensions). This concept has applications in a wide range of microwave radar and communications fields.

REFERENCE: Zmuda H. and E. N. Toughlian, "Photonic Aspects of Modern Radar," Artech House, 1994.

DARPA SB962-066 TITLE: Application of Adaptive Array Processing to Cellular Base Station Antennas

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Define and evaluate performance of a notional, low-cost base station array configuration and supporting adaptive array processing applied to the uplink and downlink.

DESCRIPTION: If a cellular base station employs an array of elements in a notional configuration, then spatial directivity and adaptive nulling can be applied to uplink and downlink processing. The algorithms of interest would have to place and maintain beams on moving sources while simultaneously nulling interference such as co-channel sources in other cells and intermod products from other base stations. Algorithm design should be robust to multipath effects and urban environments. Algorithm design should minimize computational complexity. Performance analysis should include comparison of Signal-to-Interference-plus-Noise Ratio (SINR) on typical mobile sources with and without adaptive array processing, and evaluation of the impact of adaptive array processing on link capacity.

PHASE I: Provide detailed definition of base station array and the supporting adaptive processing algorithms and processor throughput requirements.

PHASE II: Provide full simulation of system performance including detailed terrain effects. Devise simple uplink experiment to demonstrate adaptive array performance.

COMMERCIAL POTENTIAL: As the PCS market continues to grow, the need for increased capacity without degradation in service quality is likely to require the use of adaptive antennas in base stations. Several current commercial concerns have invested in adaptive array research, but a product has yet to gain a foothold in the marketplace. Once an adaptive array product gains acceptance in the marketplace, the potential international sales volume is very large.

DARPA SB962-067TITLE: Detection and Estimation in Airborne Space-Time Adaptive Radar

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop Space-Time Adaptive Processing (STAP) algorithms and accompanying detection and estimation algorithms that are robust to non-Gaussian amplitude statistics in an airborne surveillance radar environment.

DESCRIPTION: As military radar hardware developers leverage progress in miniaturized digital receiver technology, and massively parallel embedded processing capabilities, the application of sophisticated digital signal processing applications such as STAP will be feasible in fielded systems. Algorithms will be required that provide Constant False Alarm Rate (CFAR) performance without significantly degrading radar detection performance in a variety of clutter background types. Radar clutter signals are known to have non-Gaussian amplitude statistics. STAP is not optimum when the clutter statistics are non-Gaussian resulting in clutter undernulling. The resulting composite background of Gaussian receiver noise and non-Gaussian clutter residue is a challenge to CFAR detector design. A combination of STAP algorithms and target signal detection and estimation algorithms are required that are robust to a variety of pre- and post-adaptation clutter background distributions.

PHASE I: Provide detailed design of STAP and detection algorithms and provide detection performance analysis using a generic clutter simulation.

PHASE II: Evaluate algorithm performance on site-specific simulation data, and live data collected on the DARPA Mountaintop Program. Implement detailed simulation of scenarios specified by the program office using Rome Laboratory STAP for site-specific data simulation.

COMMERCIAL POTENTIAL: Future business opportunities will be aimed at DoD and commercial advanced communications systems.

DARPA SB962-068TITLE: Applications and Beamforming with Small, Wide-Band Elements

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Development and/or application of small, low-noise, wide-band antenna elements.

DESCRIPTION: The performer will carry out research and development leading to the deployment of advanced antenna apertures consisting of small, low-power, wide-band (<20 MHz to >2 GHz) elements. Efforts may include development and breadboard testing of new elements or systems applications of existing elements. The system application should involve combining these elements into array apertures characterized by wide-bandwidth and high beam-steering accuracy without significant overhead associated with power or cooling.

PHASE I: The performer will develop/define the elements to be used and analyze the performance of an array of these elements in a communications application. Priority is to be placed on the operating bandwidth and beam-steering accuracy of the aperture, and on packaging issues (size, weight, power).

PHASE II: The performer will conduct breadboard testing of the concepts developed in Phase I. The objectives of these tests will be to demonstrate the feasibility of deploying such an aperture and to characterize the expected performance.

COMMERCIAL POTENTIAL: The concepts to be explored in this SBIR project have tremendous potential for commercial implementation. Evolving communications networks, such as cellular and PCS, will rely on small, inexpensive, high-performance antennas to perform in a cost-effective manner. The antennas developed in this program will have direct commercial application in this field.

DARPA SB962-069TITLE: Lightweight Electronically Steerable Antennas

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Microwave antennas which are used for fire control may have dimensions as large as 100 wavelengths. This SBIR topic seeks to reduce the weight of these antennas by 1) relaxing requirements of physical stress (for example space or aerostat applications); 2) relaxing FOV requirements for electronic scan; and 3) using new feed and array construction techniques.

DESCRIPTION: The performer will develop new feed and array designs which achieve very large savings in weight while maintaining a large power-aperture product for fire control radar. Use of fiber optic feeds, space feeds, and composite construction techniques are among the technologies which could be considered.

PHASE I: Develop concepts and define critical experiments.

PHASE II: Fabricate array and feed subsections to validate weight estimates and performance.

COMMERCIAL POTENTIAL: Weight usually equates with cost, and in both space and terrestrial applications, microwave antennas are used for improving signal reception. Thus this technology would give a wide range of application in cost reduction.

REFERENCE: The Antenna Handbooks.

DARPA SB962-070 TITLE: Micro Sensor Systems

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Identify technologies and concepts for development of extremely small sensor systems for use as stand alone or integrated into small robots and UAVs.

DESCRIPTION: There is a need for small sensor systems which provide real-time intelligence to small units or individuals. This program is focused at research and development leading to the development of small, light-weight, low-power sensor systems for surveillance and targeting applications. Efforts may address any field of design for which significant leverage can be demonstrated. However, the areas of advanced sensors, low-power electronic systems design, and low-power wide bandwidth data links is of particular interest.

PHASE I: This phase will define/identify/develop technologies, processes, architectures, and system concepts for micro sensor systems. Expected output are: system concepts; performance assessments; size, weight, and power trades; and development initiatives.

PHASE II: Phase II focus is on small scale validation experiments for promising concepts from Phase I.

COMMERCIAL POTENTIAL: The development of small sensor systems have commercial potential for many markets. High performance sensor systems can be used by the security industry as well as support the personal communication services infrastructure.

DARPA SB962-071TITLE: Innovative Missile Warhead Kill Mechanisms

CATEGORY: 6.2 Exploratory Development; Conventional Weapons, Directed Energy Weapons

OBJECTIVE: Predicted lethality performance (via simulation) and prototype design specifications for warhead leading to prototype development.

DESCRIPTION: The next generation of advanced cruise missile and aircraft threats may employ electronic countermeasures which can enforce miss distances that exceed the effective radius of conventional air-to-air and surface-to-air missile (AAM/SAM) warheads. Concepts for innovative kill mechanisms that provide high probability of sure kill against evolving threats are of interest to DARPA. Novel designs may include, but are not limited to, mass-focused high explosive warheads, fragment shape innovations, high power microwave (HPM) warheads, or submunition packages ("mother-daughter" designs). Current and planned Army, Navy, and Air Force AAM/SAM airframes may be considered potential candidates to receive the kill mechanism upgrade. Concepts which provide engageability against threats flying down to sea level, at speeds up to Mach 3, and at all aspects is desirable. No modifications to safety, handling, and maintenance procedures should be required. Changes in requirements for fire control and/or surveillance sensors are discouraged.

PHASE I: Provide a detailed concept feasibility assessment. Include preliminary effectiveness simulation results and a development roadmap for the recommended technology.

PHASE II: Provide detailed effectiveness analysis. Perform requirements flowdown for the warhead fuse, associated fuse hardware, and support from guidance subsystems. Indicate how warhead mechanism will meet airframe volume, dimensional, and mass constraints for the warhead subsystem.

COMMERCIAL POTENTIAL: Future business opportunities will be aimed toward DoD needs.

DARPA SB962-072TITLE: New Long-Range Air Target ID Techniques using RADAR

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop advanced combat identification techniques for implementation in advanced radar systems.

DESCRIPTION: The performer will carry out research and development of advanced combat identification concepts capable of long-range detection of air targets. Techniques developed will be suitable for implementation on either advanced fire-control or surveillance radars. Techniques for consideration include, but are not limited to, radar signal modulation, Synthetic Aperture Radar (SAR), ISAR, and high-range resolution profiling. Both cooperative and non-cooperative techniques will be considered.

PHASE I: Develop a combat ID concept capable of classifying air targets at long ranges (commensurate with the kinematic ranges of projected missile technology). In detail, define the proposed algorithm and implementation approach.

PHASE II: Implement an appropriately-scaled algorithm on a radar selected in consultation with DARPA. For example, an algorithm designed for a surveillance radar might be tested on ARPA's Radar Surveillance Technology Experimental Radar (RSTER) currently operating at the Pacific Missile Range Facility. Data will be collected and the efficacy of the algorithm evaluated.

COMMERCIAL POTENTIAL: Target identification techniques have commercial application in areas where extraction of a desired object from background noise and nuisance objects is required. Examples include search-and-rescue operations and feature extraction in remote sensing operations.

DARPA SB962-073TITLE: Selective Energy Conversion into Mechanical or Electrical Power

CATEGORY: 6.2 Exploratory Development; Aerospace Propulsion and Power; Environmental Quality; Materials, Processes and Structures; Sensors; Ground Vehicles; Manufacturing Science and Technology

OBJECTIVE: Create and demonstrate concepts for scavenging power and converting high energy -density fuels into electrical power for small systems.

DESCRIPTION: In most systems size and weight of the power source are key issues affecting system design and overall performance. Also, it is often desirable to selectively use and combine discrete energy units to generate the necessary electrical or mechanical power. Present power sources have inadequate energy densities and selectivity to be used efficiently in several target applications. Novel methods of creating high energy density microsystems for storing and selectively converting energy into mechanical or electrical power are needed. Likewise, conversion by thermophotovoltaic (TPV) systems can be improved by the capability to manufacture low-cost, narrow band gap photovoltaic cells.

It is anticipated that the necessary power sources will take advantage of the high energy densities available from combustion or direct conversion of chemical energy into mechanical or electrical power. These power sources would also take advantage of microelectromechanical systems (MEMS) technology in order to minimize size and weight. Additionally, the MEMS technology would be used to create discrete power units which could be addressed individually to generate a fixed amount of power or addressed in larger groups to produce the required output powers. In short, the systems would have the following features: high energy density, small size, low weight, individually addressable power units, and minimized system cost.

These highly efficient, selectively addressable power sources are necessary for use with micro-Remotely Piloted Vehicles (RPVs), taskable machines, and microsensor systems that have been deployed in the field.

TPV is a promising new power technology that converts radiant heat into electricity. Successful development of this technology requires photovoltaic cells that are both low-cost and have a narrow bandgap. Silicon photovoltaic cells are low-cost, but the relatively short 1 micron cutoff wavelength of silicon and its indirect bandgap restricts TPV systems to either low efficiency or use of high temperature (2000° C) sources that present substantial materials issues. These cells need to have the low-cost associated with silicon concentrator cells along with the ability to collect radiation at wavelengths longer than one micron. This will enable the use of lower temperature emitters and improve efficiency with broad-band emitters operating at high temperatures. Wavelength cutoffs of 1.5 microns or greater are sought.

PHASE I: Define and demonstrate the critical aspects of the energy conversion system. For TPV, define the manufacturing process and demonstrate critical processes.

PHASE II: Develop and demonstrate an engineering prototype, show robustness of the design or process, and identify customer.

COMMERCIAL POTENTIAL: Power for remote portable and miniature equipment, and mobile systems.

REFERENCES:
1) The First NREL Conference on Thermophotovoltaic Generation of Electricity, Copper Mountain, CO (1994), AIP Press.
2) The Second NREL Conference on Thermophotovoltaic Generation of Electricity, Colorado Springs, CO (1995), AIP Press.

DARPA SB962-074 TITLE: Kinematic Sensor/Sensory Environment and Multi-Axis Workstation Interface System for Synthetic Environment Operators

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation, Human Systems Interface

OBJECTIVE: 1) Create a coupled sensor system and head mounted display with maximum freedom from umbilical. 2) Provide realistic environmental sensory stimuli for virtual environments. 3) Create and demonstrate a new device for natural interaction and control of virtual objects for use in engineering application.

DESCRIPTION: There are three aspects to Virtual Reality (VR) environments to be used in the systems engineering of complex systems: 1) An effective, minimally-intrusive system is needed that measures an operator's real-time kinematic state, interfaces with a system that correspondingly manipulates an icon of the operator in a VR environment and then displays the resulting VR view of the icon to the operator via a head-mounted display. All visual and sensor data would be transmitted using either infrared or high frequency [GHz range] radio signals so that the operator is untethered and able to walk, run, or crawl as necessary on the synthetic environment mobile platform. 2) A means for incorporating realistic environmental effects such as in a casualty--smoke, fire, heat, overpressure (from an explosive), sound, smell, texture, etc. is desired. 3) Novel, multi-axis workstation interfaces that can be used to control multiple degree of freedom systems such as mobile platforms, solid objects (e.g., virtual tools), operator icons, robot manipulators and effectors, and others. These workstation interfaces shall preferably be designed to extend human physiological proprioception and thus provide intuitive haptic interaction with the synthetic environment. The new systems shall capitalize on recent developments in Microelectromechanical Sensors (MEMS) and Actuators, such as Rotary Encoders, Multi-Axis Accelerometers and Strain Sensors, and shall use novel kinematics designs to: Minimize system cost, Increase system reliability and ruggedness, Minimize size, Minimize power consumption, and Provide an intuitive interface that basically extends physiological proprioception into the synthetic environment.

PHASE I: Define and demonstrate sensor suit and integrate with engineering application. Define wireless requirements and conceptual design. Investigate and report possible techniques and technology for providing environmental sensory stimuli. Investigate, prototype, and report concepts for the natural manipulation of virtual objects for use in engineering applications.

PHASE II: Integrate wireless sensory suit concepts and demonstrate for engineering application. Implement and demonstrate various stimuli techniques discovered in Phase I. Develop and demonstrate a multi-axis engineering prototype and implement for evaluation of design and engineering utility.

COMMERCIAL POTENTIAL: The development of these technologies will have immediate positive impact on commercial markets particularly in the entertainment industry and the training communities where realism is essential. Existing mechanisms are too limited for heavy production use in large and complex engineering projects. “Space mice,” Polhemus devices, conventional mice, etc. are not accurate, reliable, or as easy to use as they could be. All current users of interface devices could potentially utilize new devices and the market, therefore, is significant.

DARPA SB962-075TITLE: Real-Time Closed-Loop Control of Variable Geometry Fluid Mechanical Surfaces

CATEGORY: 6.2 Exploratory Development; Air Vehicles, Surface/ Under Surface Vehicles

OBJECTIVE: Develop and demonstrate an engineering prototype control surface with minimum power requirements, minimum negative influence on signature, and maximum controllability.

DESCRIPTION: The performance capabilities of future "flight" vehicles will be significantly enhanced by the use of "smart" or adaptive structures. Such structures will have the ability to sense operational and environmental stimuli and actively optimize system response to meet or enhance structural, acoustic, or fluid dynamic performance. For example, advanced submarine stern configurations will require a variety of control surfaces to actively manage aft body boundary layer flow, vorticity, propulsor inflow and intrapropulsor flow, as well as vehicle attitude. Ultimately, real-time sensing of flow conditions over attitude control surfaces could be utilized to implement advanced camber control algorithms for increased lift without flow separation and for improved tactical maneuvering performance with reduced acoustic signature. Propulsor efficiency and associated hull boundary layer/vorticity interaction could be controlled to similar advantage. Indeed, entire networks of flow sensors could be envisioned which could subsequently provide global information for orchestrated control of attitude control appendages, flow control and anti-vorticity vanes, as well as propulsor vanes and stators, for aircraft and marine vehicle applications.

Elements of a proposed technical approach should include, but not be limited to: Integrated Actuation of Discrete Chordwise Foil Segments, Integrated Surface Pressure Sensor Network to Monitor the Boundary Layer, Surface Actuation Capability to Induce or Prevent Formation of Turbulent Flow, and Servo Control System to Optimize Camber for Prescribed Surface Pressure Distributions and/or Boundary Layer Development.

PHASE I: Develop and demonstrate an engineering prototype.

PHASE II: Develop and demonstrate the concept as a control system on an airplane, torpedo, ship, or submarine model of sufficient scale to determine suitability for actual implementation.

COMMERCIAL POTENTIAL: Significant commercial potential for application to commercial aircraft to improve fuel efficiency and reduce wing/flap mechanical complexity.

DARPA SB962-076 TITLE: Advanced Systems for Detecting and Localizing Mines or Submarines

CATEGORY: 6.2 Exploratory Development; Surface Vehicles, Sensors

OBJECTIVE: Develop shipboard system for effective detection and localization of submarines either underway or sitting on the bottom; or floating, moored and buried mines in littoral waters.

DESCRIPTION: Joint Vision 2010 lays out four new concepts that will guide future military operations. One of these concepts, called Dominant Maneuver, requires mobile capabilities which allow widely dispersed forces to quickly converge to achieve their mission. Ship operations in support of Dominant Maneuver demand safe and secure movement in littoral waters. Support for forced entry involving amphibian operations requires shipboard systems capable of detecting and localizing submarines or floating, moored and buried mines in shallow waters. This research and development initiative would lead to system concepts compatible with shipboard operations which offer promise to effectively detect and localize submarines or mine threats.

Efforts may embrace a variety of sensor and geographic positioning themes. Innovative concepts which do not limit the flexibility and mobility of ship operation are of special interest.

PHASE I: Define the proposed concept in sufficient engineering detail to demonstrate feasibility and quantify expected performance measures.

PHASE II: Proof-of-principle demonstration.

COMMERCIAL POTENTIAL: Concepts developed may have commercial utility for location of sunken objects in connection with offshore oil and gas exploration and production.

DARPA SB962-077TITLE: Low-Cost Miniature Active Radar Frequency (RF) Package

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Design and fabricate of a low-cost, miniature, active RF package capable of emulating the signature of an aircraft.

DESCRIPTION: Although active RF enhancement packages have been designed and fabricated, the challenge remains to fabricate an active RF package that is very small, affordable and can generate the radar cross section of an aircraft. The RF package is envisioned for possible use in a low-cost miniature decoy. Efforts should address the frequency, power requirements, and cost associated with proposed designs. Particular interest is in packages that are capable of generating false target signatures in the frequency range of 0.1 and 18 Ghz. Technologies that produce jet engine modulation (JEM) and scintillation are desirable, but are not required.

PHASE I: Produce a detailed design, cost estimate, and a brassboard system for a laboratory demonstration that can be used by the Government for system evaluation (e.g., frequency output, power output, duty cycle, and efficiency).

PHASE II: Fabricate and demonstrate the RF payload in flight configuration. Verify unit cost estimates.

COMMERCIAL POTENTIAL: The development of RF enhancement payload technologies that are small and affordable could be used in the general aviation marketplace to enhance the signature of small commercial aircraft to increase aircraft “visibility” and enhance safety.

DARPA SB962-078TITLE: High Speed Ships and Boats

CATEGORY: 6.2 Exploratory Development; Surface/Under Surface Vehicles

OBJECTIVE: Create new hull and/or propulsion system concepts for ships and boats.

DESCRIPTION: Research and development leading to new ship concepts is sought. Advanced integrated hull and propulsion system concepts for ships and boats are of principal interest. Fast sealift for rapid deployment of forces and their heavy equipment (e.g., tanks and other vehicles) is of particular interest. Fast boats for Special Operations Forces are also of particular interest.

Advanced concepts for high speed dynamically supported ships, new hull concepts for high speed boats, and high power density prime movers for ships and/or boats are also of individual interest. In all cases, improved seakeeping, reduced motions and benefits to survivability (both signature(s) reduction and passive features) are important.

PHASE I: Analytical prediction of performance of the concept(s) proposed.

PHASE II: Experimental verification of the analytic predictions.

COMMERCIAL POTENTIAL: There is great interest in the “middle market” for high speed ocean transportation. That is, high value cargoes which, if moved quickly, could reduce inventory carrying charges. There is also a fast ferry market which allows transit over large distances but which does not require the passengers to have cabins because an overnight stay is not required.

DARPA SB962-079TITLE: Supporting Technologies for Uninhabited Tactical Aircraft (UTA)

CATEGORY: 6.2 Exploratory Development; Control Station Technologies, Air Vehicle Technologies, Manufacturing Techniques, Communications, Military Operations

OBJECTIVE: Develop enabling technologies in support of affordable UTA systems.

DESCRIPTION: UTAs are envisioned as general purpose, reusable, tactical air vehicles which combine the best advantages of Unmanned Aerial Vehicles (UAVs) and manned aircraft. Relocating the operator to an optimal information environment (control station) outside the vehicle eliminates human physiological constraints and risk factors imposed on manned aircraft, while retaining the inherent decision making and judgment of an operator "in-the-loop." Thus, UTA systems offer the potential for a greatly expanded set of mission options including missions too hazardous for manned assets, or targets inappropriate for cruise missiles. A fully implemented UTA system encompasses a wide variety of technologies. Proposals are sought to define and develop one or more enabling or otherwise critical technologies that support the evolution of a UTA system. Technology areas include, but are not limited to: 1) human-vehicle interface, including control station design; 2) refueling of unmanned vehicles; 3) low probability of intercept (LPI) and anti-jam communications for multiple air vehicle control; 4) air vehicle manufacturing techniques that capture the affordability and performance potential of unmanned systems; 5) intelligent systems/decision aids; and 6) technologies which significantly enhance system or vehicle affordability.

PHASE I: Conduct a study to define, validate and exploit one or more enabling technologies for a UTA system. Quantify the benefits of the technological approach via analysis, and/or simulation, including an assessment of capability, and impact on overall system affordability.

PHASE II: Extend development and provide functional demonstrations to validate the technological approach.

COMMERCIAL POTENTIAL: The development of enabling UTA technologies will evoke technology advances from within the commercial sector. Further advancement of these enabling technologies could lead to advances in a variety of areas, including human-computer interfaces, intelligent aids, high resolution displays, intelligent communications networks, and low-cost air vehicle manufacturing techniques.

DARPA SB962-080TITLE: Micro Unmanned Aerial Vehicle (UAV) System Design and Operation

CATEGORY: 6.2 Exploratory Development; Air Vehicles; Command, Control, and Communications

OBJECTIVE: Develop a very small (micro) UAV system - maximum characteristic dimension of 15 cm or less - for unique military applications and assess its operational utility.

DESCRIPTION: The micro UAV represents a new class of flight vehicle with inherent potential to accomplish a number of unique, difficult military missions. Mechanization of flight at these small scales has not yet been achieved under other than experimental conditions, at best. Flight vehicle concepts and designs should address critical performance attributes such as range, speed, hover, agility, and covertness, but the operational approach must address all relevant implementation issues. Operating concepts to be examined will stress those that fulfill military missions, with priority placed on missions that currently cannot be accomplished in other ways. System concepts will be evaluated on the basis of technical feasibility, ease of implementation, operational utility, and affordability. Phase I participants may wish to team with subsystem technologists and/or other offerors to improve their competitive position for Phase II and ensure a successful vehicle integration and demonstration.

PHASE I: Develop and mature system and operating concepts for proposed micro UAV candidates. Perform analysis to demonstrate system feasibility and evaluate performance parameters. As part of the design, credibly estimate vehicle cost metrics.

PHASE II: Finalize design, fabricate and demonstrate a prototype micro UAV. Perform necessary testing, including sample mission scenarios, to assess operational effectiveness.

COMMERCIAL POTENTIAL: The development of a prototype micro UAV can provide dual-use capabilities in several areas. Remote sensing and travel within hazardous environments (nuclear, chemical, biological) would include sampling in waste storage facilities as well as air sampling for toxins during firefighting operations. Disaster rescue operations would benefit from a small remote sensor with the size and agility to maneuver through areas that might be too unstable for human operations. Security operations are another obvious area for the potential use of a micro UAV.

REFERENCES:
1) Micro Unmanned Aerial Vehicles: Results of a Workshop, Advanced Research Projects Agency (ARPA), 1995.
2) Future Technology-Driven Revolutions in Military Operations, DB-110-ARPA, 1994.

DARPA SB962-081TITLE: Micro Unmanned Aerial Vehicle (MUAV) Critical Technologies

CATEGORY: 6.2 Exploratory Development; Air Vehicles; Command, Control, and Communications; Aerospace Propulsion and Power; Electronics; Manufacturing Science and Technology; Chemical and Biological Defense; Sensors

OBJECTIVE: Design and demonstrate individual or integrated critical flight enabling technologies for an MUAV. These technologies could include navigation, microelectronic integration, advanced microsystem communications, small scale flight control, and power/propulsion technologies. Other relevant technology areas, particularly those unique to enabling flight of MUAVs, will also be considered.

DESCRIPTION: The fabrication and demonstration of an MUAV with maximum characteristic length on the order of 15 cm will require development or adaptation of a broad range of technology areas. Particularly problematic are areas such as navigation, small scale aerodynamics and flight control, where research exists that could be applied innovatively to achieve combinations of the critical performance perimeters of speed, endurance, agility, and hover. Potential battery, fossil fuel and other power sources will be required to possess both high energy density and the ability to achieve relatively high energy output rates. Fuel efficient cruise and loiter miniature propulsion systems that operate in the low to medium subsonic speed regime, and that are acoustically and visually unobtrusive are of particular interest. Elements that can contribute to novel, synergistic designs - where components are multi-functional (e.g., electronic elements that also serve as primary structure) - are necessary to address severe weight and volume constraints imposed on MUAVs and will be given priority. Integration of electronic functions such as communications, navigation, sensors, processors, etc. will also be critical in achieving a UAV of this size. Proposals should focus on describing credible novel technology or integrated system concepts and designs.

PHASE I: Identify and refine technical approaches and perform experiments and/or demonstrations to validate concepts or designs.

PHASE II: Develop and test flight article components, including possible integration into a near term demonstration UAV. This phase may require teaming with other technology or system developers to assess integration issues and provide design credibility.

COMMERCIAL POTENTIAL: The development of micro UAV component technologies will be applicable to many commercial fields. Remote sensing and travel within hazardous environments (nuclear, chemical, biological) and for disaster rescue operations are potential applications of this technology in the commercial world.

REFERENCES:
1) Micro Unmanned Aerial Vehicles: Results of a Workshop, Advanced Research Projects Agency, 1995.
2) Future Technology-Driven Revolutions in Military Operations, DB-110-ARPA, 1994.

DARPA SB962-082TITLE: Modeling a Tip Vortex with Mass Injection

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Analyze the impact of tip jet mass injection on the aerodynamic characteristics of the rotor by developing a mathematical model of the tip vortex generated by a lifting rotor blade, with injection of gas (turbofan engine core and bypass flow, mixed) into the tip vortex by the tip jet nozzle.

DESCRIPTION: Tip jet reaction drive rotors offer considerable promise for military and commercial helicopter and other vertical take-off and landing (VTOL) aircraft concepts. Conventional helicopter hover analysis computer programs utilize lifting surface aerodynamic theory, which requires mathematical modeling of the rotor wake, including the rotor blade tip vortices. However, the effects of mass injection into the tip vortices by reaction drive tip jets have not been incorporated into these mathematical models.

This model must provide tip vortex diameter, strength, and roll-up characteristics, and radial and axial coordinates of the trajectory of the tip vortex as trailed by the lifting rotor blade. A computational fluid dynamics analysis may be used.

PHASE I: Develop a mathematical model of the tip vortex generated by a lifting rotor blade, with injection of gas into the tip vortex by the tip jet nozzle.

PHASE II: Incorporate the results of this modeling into an industry-accepted helicopter rotor hover performance analysis computer program.

COMMERCIAL POTENTIAL: Commercial helicopter market.

DARPA SB962-083 TITLE: Flexible Polymeric Waveguides for Optical Display Substrates

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Systems; and Command, Control, and Communications

OBJECTIVE: Demonstrate novel waveguide materials that can be used for display substrates.

DESCRIPTION: One of the desirable attributes of a future display is to achieve a paper-like functionality that allows a display to be folded into a hand-sized form factor or a wall-sized display that can be rolled up like a projector screen. Such a display would be more readily portable, or require minimal depth, and allow easy redeployment. Clearly this will require flexible substrates, and some options for reflective and emissive displays are being pursued today. Alternatively, some approaches have used rigid waveguides to direct light in a thin profile display which has the potential to scale to large areas. The use of flexible, polymeric waveguide materials can be envisioned to allow these large format displays to be rolled or folded into more convenient sizes when not in use. Challenges to be overcome include optical efficiency and either low loss switching materials, or fabrication of layered structures which can directly pipe light to specific pixels without active switching. Various approaches for full color can include broadband materials or the use of color conversion media at the specific pixel locations.

PHASE I: This Phase is intended to identify suitable candidate materials, and define the display system architecture in terms of light sources, resolution capabilities, and power requirements. Preliminary experimental characterization of concepts during Phase I is desirable.

PHASE II: This Phase will involve the fabrication and characterization of a flexible display prototype to demonstrate the operational characteristics of the proposed systems. The prototype device should be a minimum of 1/4 VGA (320 x 240 pixels) and may be monochrome, although color is preferable. Estimation of fabrication costs in volume.

COMMERCIAL POTENTIAL: The development of such a patterning technology will be well suited to a variety of military and commercial needs. For both professional and consumer use, the ability to have a display that requires minimal space when not being viewed would be a significant advantage over today's bulky large screen systems. In portable applications, module sizes could be significantly reduced if the display could be made more compact when not in use.

REFERENCES:
1) Veligdan, J.T., Proc. SPIE, Vol. 2462, pp. 94-101 (1995).

2) Morreale, Jay, ed., Society for Information Display International Symposium, Digest of Technical Papers, Vol. XXVI (1995).
3) World Wide Web DARPA/ETO Home Page (see High Definition Systems) , URL http://esto.sysplan.com/ESTO/

DARPA SB962-084TITLE: Development of Novel Toners for Direct Printing of Conducting and Insulating Patterns

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Systems; and Manufacturing Science and Technology

OBJECTIVE: Demonstrate new toner materials and binders suitable for direct electrostatic printing of fine (< 5 micrometers) features that are conductive or insulating for use in microelectronics, display, or electronic packaging applications.

DESCRIPTION: Recent work (see reference 1 below) has demonstrated the feasibility of using electrodeposition techniques (e.g. laser printing) to deposit toners which can serve as in-situ lithography masks or as sacrificial layers for lift-off processing. In such applications, typical carbon-based toners are opaque enough to serve as masks, but the toner materials do not have physical properties desirable for final device structures. The ultimate potential of electrodeposition patterning will be using this technique to directly and selectively pattern conducting or insulating structures without requiring additional processing. While some toners or precursors exist with suitable properties, they are typically much larger than desired for fine patterning, and the binder materials used are not suitable for final devices. The unavailability of these materials today is the limiting factor in aggressively pursuing direct patterning by electrodeposition. This SBIR topic will include the identification and preparation of novel toner materials that can be used for direct patterning of submicron conducting or insulating features, and their demonstration and evaluation in printing appropriate structures.

PHASE I: This Phase is intended to identify suitable candidate materials, analyze the improvements necessary for direct patterning of fine features, and define suitable processing conditions for the electrodeposition process. Preliminary experimental characterization of concepts during Phase I is desirable.

PHASE II: This Phase will involve the fabrication and characterization of an operational test device to demonstrate the application of direct printing in the fabrication process. Such a demonstration should produce a device comparable to those found in commercial practice, and the relative manufacturing costs of the electrodeposition process relative to traditional processing should be quantified.

COMMERCIAL POTENTIAL: The development of such a patterning technology will be well suited to a variety of military and commercial needs. Many non-critical lithography applications could be replaced by such a process, which will require less expensive capital equipment and significantly reduce materials consumption.

REFERENCES:
1) Gleskova, H., S. Wagner, and D. S. Shen, Electron Dev. Let. 16, pp. 418-420 (1995).
2) Morreale, Jay, ed., Society for Information Display International Symposium, Digest of Technical Papers, Vol. XXVI (1995),
3) World Wide Web DARPA/ETO Home Page (see High Definition Systems), URL http://esto.sysplan.com/ESTO/