DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR Program rests with the Office of Administration and Small Business. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/OASB/SBIR
Attention: Dr. Bud Durand
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448

The proposals will be processed in the Office of Administration and Small Business and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 97 technical topics, numbered DARPA 92-130 through DARPA 92-226, to which small businesses may respond in the second fiscal year (FY) 1992 solicitation (92.2). Please note that these are the only topics for which proposals will be accepted at this time. Proposals can no longer be accepted on those previously advertised 129 technical topics which were numbered DARPA 92-001 through DARPA 92-129. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from DARPA technical offices.

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 applicability as the budget and other factors will allow. In the early years of the SBIR program, most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. DARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II limit was lowered to $250,000.

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 proposals 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 can only respond to one topic.

DARPA has prepared a checklist to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or handcarrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1992 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. Post Potential Applications ____

i. Key Personnel ____

j. Facilities/Equipment ____

k. Consultants ____

l. Prior, Current, or Pending Support ____

m. Cost Proposal - Appendix C ____

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, including cost proposal (Appendix C) 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. ____

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

c. One additional photocopy of Appendices A and B only. ____

SUBJECT/WORD INDEX TO THE DARPA FY92 SBIR PHASE I TOPICS

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

FY 1992 Small Business Innovation Research Topics

DARPA 92-130 TITLE: Multi-Media Network-Layer Protocols to Support Meteor Burst (MB) and Other Communication Media

CATEGORY: Exploratory Development

OBJECTIVE: To design, develop, simulate, and demonstrate robust, multi-media distributed network protocols that can support data or digital voice in a network of nodes using MB and other communication media as links.

DESCRIPTION: Concepts are sought for distributed network-layer protocols that will automatically select from among a group of media and optimally manage routing, access, congestion, and priority in support of voice, data, and video services for a group of mobile, non-homogeneous nodes. Media such as MB (including random occurrences of sporadic 'E' propagation), HF, or store and forward LIGHTSAT should be considered. The network should provide for a variety of optimization criteria, e.g., maximizing throughput, minimizing detectability in selected sectors or regions, providing maximum robustness against jamming or other hostile attacks, and minimum delay for fixed-length messages or short bursts of voice, video snippets, or map overlays. Novel network protocols should take advantage of improvements in MB communication data rate capability made possible by DARPA's advanced MB technology project and the work to be performed under DARPA SBIR-92. The network protocols must be capable of interfacing with high-layer standard packet switched protocols such as TCP/IP or ST, and with lower-layer protocols developed under DARPA SBIR-92. Concepts will be analyzed and simulated, reduced to practice, interfaced with other protocols (higher and lower in layer) and field tested in a proof-of-concept demonstration.

Phase I: Design multi-media network protocols. Design the algorithms to implement them. Analyze and/or simulate the performance under all optimization criteria. Provide performance data from this analysis/simulation.

Phase II: Implement the network protocol algorithms so that they run in real time in a machine. Support the demonstration of this machine programmed with the network protocol algorithms with MB, LIGHTSAT, and HF media at lower layers and with the Defense INTERNET Network at the next higher layer.

DARPA 92-131 TITLE: Digital Voice Processing and Link Protocols for Meteor Burst (MB) Communication Networks

CATEGORY: Exploratory Development

OBJECTIVE: To design, develop, simulate, and demonstrate on an advanced MB link a voice digitization technique and a link protocol that effectively supports near real-time, interactive, full- or half-duplex conversational voice and voice commands.

DESCRIPTION: Concepts are sought for digital voice processing algorithms and the link protocols to support them on a high-speed MB (including random occurrences of sporadic 'E' propagation) link. Voice quality and intelligibility comparable to the LPC-10 algorithm operating at 2400 BPS is a goal. Recognizing the variability of the MB channel data rate, the protocols should minimize delay time in accordance with the availability and instantaneous capacity of the channel. Concepts will be analyzed and simulated to determine performance in the MB channel, reduced to practice to run in real time, interfaced with lower- and higher-layer MB protocols, and field tested in a proof-of-concept demonstration.

Phase I: Design voice digitization and link-layer protocols. Design the algorithms to implement them. Analyze and/or simulate the performance of the algorithms for the MB channel. Provide performance data from this analysis/simulation.

Phase II: Implement the algorithms so that they run in real time on a machine. Support the demonstration of this machine programmed with the real-time voice digitization and link-protocol algorithms in a field demonstration. The voice processing and link protocols shall be interfaced with lower-layer MB protocols and with a network-layer protocol to be determined at a later date.

DARPA 92-132 TITLE: Low-Cost, Non-Destructive Inspection of Aircraft Composite Parts

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate low-cost techniques to inspect composite parts, graphite epoxy-honeycomb core combinations for ply-ply and bond-line delaminations. The primary applications of these techniques will be to advance aircraft and unmanned air vehicles (UAVs).

DESCRIPTION: Advanced manufacturing technology utilizing composite structures is proliferating throughout the aircraft industry. Unmanned air vehicles have tended to be prime users of composite parts to minimize vehicle empty weight. The ability to inspect these parts in a timely, efficient, and low-cost manner is a prime concern of the operational community. Inspections of UAVs need to be performed at the factory during fabrication and in the field after missions have been completed.

Phase I: Develop techniques for low-cost inspection of composite parts. Technique should not be highly labor intensive nor should it in any way require damaging the part. A technique which is capable of working from a single side of the part is preferred. Three types of composite parts should be addressed: Solid graphite/epoxy thick layups; graphite/epoxy skins over honeycomb core; and, graphite/epoxy skins over closed cell foam core. (For reference typical aircraft wings/tails have dimensions in the order of 30'x6'.)

Phase II: Build or acquire representative composite aircraft parts. (Three part types listed in Phase I are required.) Demonstrate the inspection technique developed under Phase I. Emphasis should be placed on reliability of results and minimizing composites, inspections, and non-destructive cost of part inspections.

DARPA 92-133 TITLE: Novel Concepts for Incorporating MILSATCOM Capabilities as One Transport Layer in a Multi-Band, Multi-Waveform, Multi-Media Network Architecture

CATEGORY: Exploratory Development

OBJECTIVE: To elucidate and explore novel concepts for the incorporation of military satellite communications within multi-media network architectures. Provision for multi-band and multi-waveform operation is desirable.

DESCRIPTION: In recent years, extensive work in the fields of communications, computers, and information processing has produced significant capabilities in local and wide-area network architectures. This trend will continue to grow in the commercial sector and is also being integrated into the command, control, communications, and information processing structures within the Defense community. Requirements for Radio Frequency (RF) networking may be expected to escalate as the Defense establishment adopts a doctrine of rapid global deployment from CONUS bases under crisis conditions. RF networks offer the military capabilities for mobile operations and rapid establishment of a warfighting command and control infrastructure in a developing theater of operations. The use of networks which incorporate satellite-based nodes is of particular interest and importance because the space segment introduces advantages of reduced terrestrial communications infrastructure (enhancing rapid deployments and mobility), non-line-of-sight and very wide-area connectivity and global reach gateways. The present study will address system concepts to optimally employ communications satellites to support future advanced networking capable of providing connectivity with mobile terminals at data rates appropriate for future needs (real-time video, communications, etc.). Distributed processing should be considered to include on-board satellite capabilities. Integration into a multi-media network architecture is desirable and enhanced system performance based on multi-band, multi-waveform capable equipment should be addressed.

Phase I: Develop preliminary system concepts to incorporate satellite communications into future multi-media network architectures with considerations for multi-band, multi-waveform operations, and distributed processing environment.

Phase II: Develop a simulation model to investigate system performance, including congestion scenarios, implications of throughput, synchronization requirements, and other relevant issues.

DARPA 92-134 TITLE: Passive Airborne Receipt and Display of Weather and Air Traffic Data

CATEGORY: Advanced Development

OBJECTIVE: To combine data fusion of environmental (weather) and air traffic (radar) data with application of packet and stream communication technology (e.g., cellular phones) to provide low-cost receipt and display of "all source" distributed, real-time, on-board situational awareness information.

DESCRIPTION: DARPA is investigating advanced technologies to provide passive, on-board receipt and display of weather data and air traffic information for operation of military and commercial aircraft. Multiple sources exist for commercially accessible correlated weather satellite imagery, weather radar, and other environmental sensor outputs. Air traffic control radar networks provide accessibility to real-time positioning of aircraft. Communication technology has advanced to provide support to distributed data networking. Computing technology provides the throughput and display capability adequate for on-board display and control of voluminous data flow. This effort must combine all these technologies in a synergism between ground data fusion and control, "cellular" transmission, and on-board receipt and display of all available data. An aircraft travelling the continental United States should be able to continuously display real-time spatial relationships for weather and other aircraft, using only a receiver, modest computing, and a color display. System concepts may provide for self-contained inertial reference, possibly using a Global Positioning System receiver system. Possible approaches could include use of innovative signal processing, data compression, bulk, stream and packet transmission, data fusion, and integration and filter techniques. The systems must provide self-contained software and hardware for flight path assessment processing. Any integrated data processing software should be contained in plug-in, solid-state modules to permit replacement or upgrade of the software. The system must have output ports and input/output control appropriate to the system concept output data, but consistent with commercial practices for data transfer among avionics systems onboard current generation military air vehicles (e.g., 1553B data bus). The system should provide for a dedicated color display capability. Systems must be able to be adapted to a variety of platforms through the software loading of air vehicle parameters (flight characteristics and "acceptable" flight profiles). Although system performance and continuity of data is of primary concern, low-cost, low-power, low-maintenance, and light-weight system concepts provide the greatest potential for integration across military and commercial vehicles. Strong emphasis will be placed on truly innovative concepts that offer the potential for radical leaps in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally incorporated into air vehicles and utilized. Both the ground data collection and processing, as well as the airborne receive and display requirements must be satisfied.

Phase I: Provide detailed analysis of the proposed data collection, fusion, processing, compression, transmission, reception, decompression, and display techniques to be used to provide the air vehicle and its operator with real-time updates of environmental data and air traffic. Provide detailed analysis of the functional design of the proposed hardware technologies and requisite software to be incorporated in the ground and airborne segments of the system. Describe system test considerations and effort required for incorporation for ground and flight test.

Phase II: Develop an end-to-end feasibility demonstration of the ground and airborne system elements and demonstrate their performance.

DARPA 92-135 TITLE: Design and Simulation of Strap-Down Guidance for a Low-Cost Smart Submunition to Attack Critical Mobile Targets

CATEGORY: Basic Research

OBJECTIVE: To develop and demonstrate a system concept for the use of strap-down guidance to reduce the cost of autonomous submunitions for attacking targets with various degrees of hardness. Both submunition cost per unit and cost-effectiveness (cost per kill) are to be improved through use of the strap-down design.

DESCRIPTION: The sensor gimbal is a significant cost item in a guided munition. Elimination of this gimbal removes one cost element but increases the difficulty of munition guidance. This effort will investigate the major subsystems involved and the data and signal processing required to overcome the difficulties introduced by an inability to keep the target on sensor boresight regardless of munition maneuvers. Because of the range of target hardness that must be considered and the range of submunition flight-control mechanisms that might be used (e.g., fin-guidance, parachutes, powered flight), a variety of guidance algorithms will be examined to determine if a generic guidance process can be applied to multiple classes of munition designs. Both shoot-to-kill and hit-to-kill

submunitions will be addressed. Six-degree-of-freedom simulations will be developed and exercised to test the guidance concepts and resolve design trade-off issues.

Phase I: Develop an innovative system concept for submunition cost reduction through use of strap-down guidance. Define requirements and explore the spectrum of submunition components and algorithmic processes possible. Select and demonstrate a recommended approach. Develop a plan for system concept simulations. Justify qualitative cost and robustness considerations.

Phase II: Design an optimized low-cost submunition concept. Define and characterize all major subsystems and perform six-degree-of-freedom simulations to demonstrate concept feasibility and algorithmic robustness. Provide a development plan for a low-cost system feasibility demonstration.

DARPA 92-136 TITLE: Estimation of Missile Launcher Position from Limited Observations of the Trajectory after Launch

CATEGORY: Basic Research

OBJECTIVE: To develop and demonstrate a system concept to estimate the launch position of theater ballistic missiles from a limited number of angle-only observations of the missile during flight. The system is to operate in near real-time and with sufficient accuracy to allow the missile launch position to be targeted for counterstrike.

DESCRIPTION: Experience in the Gulf War demonstrated the importance and the difficulty of locating and quickly neutralizing enemy theater ballistic missiles (TBMs). This effort will investigate the feasibility of an accurate estimation of TBM launcher position from a limited number of observations of the missile after launch. The signature of a TBM during its boost phase provides opportunity for passive detection: an angle-only sensor may be sufficient, avoiding the use of active sensors. However, it may not be possible to rely on passive observations from long range until the TBM has cleared the clouds, limiting the time for observations before the booster burns out and the target signature is diminished. In addition, the passive sensor may be required to monitor a large area, obtaining observations only periodically in any given direction. This effort will consider sensors and evaluate them for applicability and range implications. Sensor location and viewing angle will be investigated. Algorithms for near real-time estimation of launcher position based on the observations will be prepared and simulated. Minimizing the number and cost of sensors and the complexity of the signal/data processing required to effect the position estimation is clearly beneficial. More accurate position estimation simplifies the counterstrike, but system performance must be balanced with cost and operational reliability. The contractor will be provided SECRET data from actual missile flight profiles. The contractor will adapt this data to provide the basis for simulations that demonstrate the position estimation process selected.

Phase I: Develop an innovation system concept for estimation of TBM launcher position (for use in counterstrike). Perform target signature analyses, define example stand-off sensors, and define and demonstrate an algorithmic concept simulation based on actual missile flight data. Justify qualitatively the cost and robustness considerations used to select sensor and operational parameters.

Phase II: Perform a preliminary design of the sensor and an optimized set of processing algorithms. Demonstrate their superiority through complete simulations based on actual missile flight profile data. Quantify the cost and robustness considerations of Phase I. Provide a development plan for a low-cost system feasibility demonstration.

DARPA 92-137 TITLE: Porting MACH to New Processors and Systems of Processors

CATEGORY: Exploratory Development

OBJECTIVE: To develop a broad base of computers/architectures with compatible and portable operating system (OS). Encourage transition to modular computing systems software architectures.

DESCRIPTION: Developer will port the MACH OS to a particular computing system and document issues associated with the port. Specific product will be the availability of MACH as supported product on this processor.

Phase I: Conduct appropriate studies to support the port of MACH to the target computer and port the MACH OS to that machine. The port, at the end of Phase I, may only have a limited number of devices and can be

run as an Alpha quality product.

Phase II: Extend the port to include a reasonable suite of devices for the target processor. In addition, the port will be tested and stabilized to bring it up to standards necessary for broad use.

DARPA 92-138 TITLE: Generic Device Drivers (Boesch)

CATEGORY: Exploratory Development

OBJECTIVE: To extend the usability of the MACH operating system (OS) through development of non-proprietary drivers for a broad class of devices.

DESCRIPTION: The limiting factor in broad distribution of the MACH OS is the availability of distributable device drivers for the broad class of devices available to today's computer. This effort will produce drivers suitable for distribution with MACH from Carnegie Mellon University.

Phase I: Develop a specification of the device driver, and design and complete preliminary implementation of the driver. Successful completion of Phase I will result in a demonstrable device driver.

Phase II: Complete the driver, add a full suite of error detection and correction interfaces, and improve the robustness of the implementation to bring the system to a quality suitable for inclusion in the MACH distribution.

DARPA 92-139 TITLE: Tools for User Interface and Widgets in the NeXTStep and X-Windows Systems

CATEGORY: Exploratory Development

OBJECTIVE: To enhance the usability of both the NeXTStep and X-Windows systems by the introduction of a number of useful components enabling application writers to directly incorporate gauges, dials, sliders, graphics views, etc., into their applications.

DESCRIPTION: This task will result in distributable widgets or objects for X-Windows and NeXTStep windowing systems. The objective is to raise the level of abstraction of application programmers through the availability of high functionality generic components.

Phase I: Design and implement the widgets or objects. This phase will result in a demonstrable component; however, it is expected that the component will only implement a limited set of its eventual functionality.

Phase II: Complete the component designed in Phase I, improve the robustness, and package and document the component suitably for distribution throughout INTERNET.

DARPA 92-140 TITLE: Developing New MACH Servers

CATEGORY: Exploratory Development

OBJECTIVE: To extend the functionality of advanced systems through introduction of modular servers. Specific areas include trust, encryption, and distributed services.

DESCRIPTION: Modular services are the key to implementation of high-performance systems while maintaining high degrees of portability. This effort encourages the implementation of a number of advanced services in the context of the MACH operating system (OS).

Phase I: Conduct studies and design a server for the new proposed service. The architecture of the server will be defined and it will be shown to support the overall MACH OS architecture.

Phase II: Implement the server designed in Phase I and demonstrate its operation in a simple application.

DARPA 92-141 TITLE: Developing New INTERNET Services

CATEGORY: Exploratory Development

OBJECTIVE: To develop INTERNET services and protocols which offer innovative functionality, enhanced performance, substantial cost reductions, or greatly enhanced scalability. Higher-level protocols and server implementations are preferred; proposals including hardware design and development must demonstrate exceptional merit.

DESCRIPTION: Research leading to services which will substantially enhance INTERNET capabilities is sought. Efforts which provide incremental improvements or which provide only part of a service are not desired. Implementations must take advantage of existing open protocols, systems, and standards where possible. All proposals should clearly define the target user community. All must address the issue of operation in environments ranging from small networks to the global INTERNET, with emphasis on distributed management and control, communication bandwidth, and other requirements. Portable software is preferred. Implementation languages, operating systems, and other restrictions must be identified. All must supply full information regarding any proprietary technology and associated licensing terms. Novel services must be clearly defined. Implementations of existing services with higher levels of performance or scalability must be upward compatible and must contain a clear comparison with the characteristics of existing implementations.

Phase I: Deliver a detailed design and cost information, as well as a complete plan for implementation. Prototypes demonstrating feasibility are desired.

Phase II: Deliver a full implementation and demonstration of the service. Supply complete user documentation, source code, and system designs.

DARPA 92-142 TITLE: Technology for Technical Library Services in the INTERNET

CATEGORY: Exploratory Development

OBJECTIVE: To develop technical library services which address the needs of the computer and communications community.

DESCRIPTION: Technology leading to on-line availability of technical information over the INTERNET is desired. Proposers must clearly identify the information, sources, collection methods, dissemination scheme, and user services to be provided. Proposals must clearly identify all required hardware, software, operating system, protocol, and other supporting infrastructure. Implementations which are scalable across different communications capabilities and offer timely updates are preferred. Proposals must give a concise description of the target user community and compare the proposed work with existing methods. Proprietary components must be described and the proposed service must be compared with existing information distribution methods. Plans for dealing with copyrights and other intellectual property rights must be discussed, if applicable.

Phase I: Deliver a detailed design and cost information, as well as a complete plan for implementation. Prototypes demonstrating feasibility are desired.

Phase II: Deliver a full implementation and demonstration of the service. Supply complete user documentation, source code, and system designs.

DARPA 92-143 TITLE: Tools for Visualizing, Measuring, Analyzing, and Debugging INTERNET Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop tools which enable enhanced measurement, analysis, and debugging of INTERNET systems. Tools providing user-friendly visual interfaces are preferred.

DESCRIPTION: Tools providing innovative capabilities for measuring, analyzing, and debugging INTERNET systems are sought. Efforts which will provide incremental improvements or which provide only part of a capability are not desired. Implementations must take advantage of existing open protocols, systems, and standards where possible. Designs must provide a powerful user interface. Designs providing completely new capabilities and empowering users with little knowledge of underlying protocols and systems are of particular interest.

Proposals must contain a clear description of the target user community and a comparison with existing methods.

Phase I: Deliver a detailed design and cost information as well as a complete plan for implementation. Prototypes demonstrating feasibility are desired.

Phase II: Deliver a full implementation and demonstration of the service. Supply complete user documentation, source code, and system designs.

DARPA 92-144 TITLE: Tools for Hardware/Software Design Modeling and Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative approaches and tools which model and simulate hardware/software tradeoffs in computing systems design.

DESCRIPTION: Concepts are sought for approaches leading to techniques, methods, and tools to qualitatively and quantitatively model and simulate partitioning tradeoffs between hardware and software in a subsystem design. Approaches exploiting existing standards, open interfaces, and available design data will be preferred. Limitations, domains, and applicability for these approaches must be quantified. Demonstrations should support the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: Define in detail the technology, tradeoffs, interfaces with other tool suites, benefits, domains, and risks, along with supporting evidence of success such as early prototyping experiments. Approaches should be able to be integrated, where possible, into other commercial CAD platforms and adhere to emerging industry CAD standards.

Phase II: Develop tools, supporting documentation, and test cases which demonstrate and prove the methods and approaches in Phase I. Tools should be demonstrated in at least two computing subsystem applications that show the hardware/software tradeoff analysis.

DARPA 92-145 TITLE: Tools for System Level Modeling of Computing Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop approaches and tools which model and simulate system design tradeoffs for computing systems.

DESCRIPTION: Concepts are sought for approaches leading to techniques, methods, and tools to model and simulate tradeoffs in designing advanced computing systems. Abstracting validated and experimental data might be used to assist designers to rapidly investigate alternates such as interconnection bandwidths, network interfaces, sensor-based approaches, or electromechanical systems. Rapid, flexible methodologies are sought to accelerate the system design process. Limitations, domains, and applicability for these approaches must be quantified. Demonstrations should support the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: Define in detail the technology, tradeoffs, interfaces with other tool suites, benefits, domains, and risks, along with supporting evidence of success such as early prototyping experiments. Approaches should be able to be integrated, where possible, into other commercial CAD platforms and adhere to emerging industry CAD standards.

Phase II: Develop tools, supporting documentation, and test cases which demonstrate and prove the methods and approaches in Phase I. Tools should be demonstrated in at least two computing subsystem applications that enable alternative system designs to be realized.

DARPA 92-146 TITLE: Defense-Specific Computing Accelerators

CATEGORY: Exploratory Development

OBJECTIVE: To develop and quantify performance of specific hardware/software accelerators which can operate in a systems context for Defense.

DESCRIPTION: This solicitation seeks research and development of specific, small-scale, hardware accelerators for DoD. Hardware and software solutions, capable of running in collaboration with general purpose computing, are sought which can accelerate classes of Defense problems by 2-3 orders of magnitude over general purpose solutions. The ability to rapidly prototype the accelerators is essential. Approaches exploiting existing standards, open interfaces, and scalable technologies of future generations of computing will be preferred. Limitations, domains, and applicability for these approaches must be quantified. Demonstrations should be consistent with the goals of the Federal High Performance Computing and Communications (HPCC) program and be focused on high payoff Defense opportunities.

Phase I: Define in detail the candidate accelerator, technical approaches, interfaces, tradeoffs, and risks, along with supporting evidence of success, such as early prototyping experiments. Expected performance must be determined, along with related trends in general purpose solutions and comparisons to existing state of the art.

Phase II: Prototype, develop, demonstrate, and deliver the accelerator, along with associated documentation and testing strategy to compare results to predictions.

DARPA 92-147 TITLE: Technology Computer Aided Design (TCAD) Algorithms on a Scalable Computing Base

CATEGORY: Exploratory Development

OBJECTIVE: To develop new algorithms to support electronic TCAD that have potential to execute both on workstations and massively parallel computers.

DESCRIPTION: New algorithm families implemented in design tools are sought for approaches leading to innovations in TCAD. These algorithms will be the basis of the next generation of design for advanced electronic devices, processes, packaging, or electromechanical subsystems, and must be capable of executing on computing systems ranging from certain workstations to massively parallel computers. Such algorithms should support the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: Define in detail the application, algorithm(s), tradeoffs, and comparisons to existing approaches, along with supporting evidence of success such as early prototyping experiments or simulation results.

Phase II: Develop and demonstrate a tool, implementing the algorithm, along with supporting documentation and test cases which clearly demonstrate its feasibility. Evidence of its ability and performance running on scalable parallel computing must be delivered.

DARPA 92-148 TITLE: High-Performance Tools for Microsystems Design

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative approaches leading to tools which optimize on performance criteria such as speed, density, and power, and are able to be used with various integrated circuit technologies.

DESCRIPTION: Concepts are sought for approaches leading to techniques, methods, and tools which optimize a desired performance criteria while maintaining technology independence over a range of integrated circuit technologies. Limitations, domains, and applicability for the recommended approach must be quantified. Demonstrations should support the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: Define in detail the technology, tradeoffs, interfaces to other tool suites, benefits, domains, and risks, along with supporting evidence of success, such as early prototyping experiments. Approaches should be able to be integrated, where possible, into other commercial computer aided design (CAD) platforms, and should adhere to emerging industry CAD standards.

Phase II: Develop tools, supporting documentation, and test cases which demonstrate and prove the methods and approaches in Phase I. Tools should be demonstrated in at least two computing subsystem applications that show the hardware/software tradeoff analysis.

DARPA 92-149 TITLE: Compiler Backends and Optimizers for Advanced Processors and Systems of Processors

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel ideas for advancing compiling technology for scalable parallel computers, particularly in the area of code optimization and parallelization for processors and scalable computing systems.

DESCRIPTION: Concepts are sought for innovative and novel ideas for advancing compiling technology, particularly parallelization and optimization, for scalable parallel computers. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed concept, principle, or algorithm. Describe new or novel ideas or concepts. Describe parallel language features. Demonstrate how the new concept, principle, or algorithm would be used. Finally, describe the path or process for implementation on advanced processors or scalable parallel system.

Phase II: Develop the software prototype, subsystem, or module which implements the new compiler technology. Demonstrate the effectiveness of the new technology. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hard copy and a magnetic media copy of the code are required. The magnetic media copy is to be delivered in ASCII form and must be in Unix Tar Format.

DARPA 92-150 TITLE: Tools for Visualizing, Measuring, Analyzing, and Debugging Parallel Systems

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel ideas for advancing graphically based debugging technology for scalable parallel computers.

DESCRIPTION: Concepts are sought for innovative and novel ideas for advancing graphically based performance analysis, performance measurement, and debugging technology, particularly non-intrusive concepts, for scalable parallel computers. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed concept, principle, or algorithm. Describe new or novel ideas or concepts. Describe how the new technology would work in the workstation server model. Demonstrate how the new concept, principle, or algorithm would be used. Finally, describe the path or process for implementation on scalable parallel systems.

Phase II: Develop the software module which implements the new performance evaluation or debugging tool. Demonstrate the effectiveness of the new technology using a scalable computing system. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hard copy and a magnetic media copy of the code are required. The magnetic media copy is to be delivered in ASCII form and must be in Unix Tar Format.

DARPA 92-151 TITLE: Technology Supporting Scalable Software

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel ideas for scalable algorithms for software library modules that can be developed into functioning code for scalable computing systems or to explore novel concepts for supporting scalability in libraries.

DESCRIPTION: Innovative concepts are sought for developing scalable algorithms and software libraries of beta release quality for scalable computing systems. The software needs to be fully compatible with the workstation

server model. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces. Novel concepts are also sought for supporting scalability in libraries.

Phase I: Provide a detailed specification of the proposed software -- collection of algorithms, library, tool, or methodology. Describe its use, with focus on its use in current or developing scalable computing environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module, collection of algorithms, library routine, tool, or methodology. Develop a user's manual which clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hard copy and a magnetic media copy of the code are required. The magnetic media copy is to be delivered in ASCII form and must be in Unix Tar Format.

DARPA 92-152 TITLE: Polycrystalline Diamond Finishing for Multi-Chip Module (MCM) Substrate Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop cost-effective manufacturing processes for finishing 4" x 4" free-standing diamond substrates for MCM packaging applications.

DESCRIPTION: The Multi-Chip Module (MCM) packaging concept offers increased system speed with decreased size, but thermal and physical demands on the MCM package are severe. Manufactured polycrystalline diamond for substrate applications will provide excellent thermal conductivity and superior stability. However, cost-effective finishing techniques are necessary to achieve the surface roughness and flatness required to meet the stringent demands of large area MCM processing. Process control is essential to ensure proper finishing, and in-situ sensing and application of advanced control techniques must be developed and demonstrated as part of this effort. Diamond substrate manufacturing is not included under this topic.

Phase I: Identify and demonstrate technical feasibility of diamond substrate finishing with quantitative testing of the diamond surface.

Phase II: Implement prototype finishing device. Demonstrate cost-effective finishing, quality, and yield of 4" x 4" polycrystalline diamond substrates. Test finished specimens and quantify results.

DARPA 92-153 TITLE: Computer Simulation of the Structure and Properties of Materials

CATEGORY: Basic Research

OBJECTIVE: To develop fast interactive computer programs to allow materials scientists to calculate the basic thermodynamic properties of crystalline solids and liquids and their defects for a wide range of elements and alloys. These programs should have user-friendly graphical interfaces for users with minimal computational experience.

DESCRIPTION: Recent advances in theoretical descriptions of atomic interactions have made it possible to make quantitative predictions of the properties of crystals and crystalline defects. Two recent developments, the Embedded Atom Method (EAM) and the Equivalent Crystal Theory (EQT), are of particular importance. General, simple to use, fast codes which may be used to calculate the standard array of crystal and defect properties are desired for use by material developers. These codes will make use of the best potentials available for the collection of elements that comprise materials of interest. User-friendly, graphical interfaces, such as those currently in use in the pharmaceutical industry, may be adapted for development of these software packages. Codes should be written in a modular form to allow easy incorporation of new advances in the description of atomic interactions. It is anticipated that these programs will allow the user to examine large numbers of material combinations and/or dopants, and determine the effects of stress, temperature, and concentration on thermodynamic and defect properties.

Phase I: Demonstrate fundamental predictive capability of the code on a subset of materials and potentials.

Phase II: Develop fully capable, modular code with a user-friendly graphical interface. The software package should offer a full range of potentials, materials, and properties of interest to materials designers.

DARPA 92-154 TITLE: Atom-by-Atom Manufacturing Processes for Multilayer Structures

CATEGORY: Exploratory Development

OBJECTIVE: To develop high throughput manufacturing technologies for multilayer structures.

DESCRIPTION: Multilayer structural materials potentially offer increased performance, functionality, and cost-effectiveness. High-rate fabrication technologies with high throughput and accurate control of layer thickness and compositions are required. Enhanced implementations of vapor deposition techniques such as Physical Vapor Deposition (PVD) or Chemical Vapor Deposition (CVD), with rapid switching for alternating layer materials, are potential approaches of merit; however, innovative high-rate, atom-by-atom deposition techniques are encouraged. Fabrication of atomic scale layered metallic, ceramic, and alloy structures requires precise control of deposition rates, switching times, deposition temperature, and other process variables. Intelligent manufacturing methods, including process modeling, in-situ sensing, and application of advanced control techniques, should be employed.

Phase I: Identify and demonstrate feasible manufacturing processes for production of multilayer structures. Quantitatively evaluate functional effectiveness of multilayer structures produced.

Phase II: Develop and demonstrate a high-rate, multilayer structure manufacturing process and intelligent control technologies. Produce, characterize, and quantitatively evaluate functionality of multilayer materials produced.

DARPA 92-155 TITLE: Compliant Bonding and Functional Layers for Thermal Stress Reduction in Diamond Substrate Multi-Chip Modules (MCM)

CATEGORY: Exploratory Development

OBJECTIVE: To develop functionally compliant layers to reduce the stress induced by the mismatch in thermal expansion coefficient between diamond substrates and the multiple layer structure of MCMs, including the bonded integrated circuit chip, as well as dielectric, ground plan, power, and interconnect layers.

DESCRIPTION: Large-area, polycrystalline, free-standing diamond provides superior heat dissipation and mechanical properties as substrates in electronic packages. For many applications, however, the difference in coefficient of thermal expansion (CTE) between the diamond substrate and other MCM parts may result in device failure. Functionally compliant layers which accommodate these thermal stresses may be required for development of large-area diamond substrate MCMs. Multilayer structure technologies may offer a potential solution; however, other innovative solutions are also encouraged.

Phase I: Identify, characterize, and demonstrate MCM-compatible processing and practical feasibility of the functionally compliant material.

Phase II: Develop and demonstrate MCM-process compatible manufacturing technology for functionally compliant material. Produce compliant layer MCM structures and quantitatively characterize performance.

DARPA 92-156 TITLE: Concurrent Engineering (CE)

CATEGORY: Exploratory Development

OBJECTIVE: To explore new ideas for technology that will enable CE of Defense products and systems for the purpose of greatly reducing cost and increasing quality.

DESCRIPTION: The term "concurrent (or simultaneous) engineering" connotes the integrated, concurrent design of products and their related processes, including manufacturing and support. There are numerous programs within the DoD and industry concerned with the development and promotion of methodologies, tools, organizational structure, and cultures for CE. By contrast, this SBIR offering is more restricted in scope in that its primary objective is to identify and develop new technologies which enable CE by DoD producers. Enabling technologies may include those for enhanced information sharing/comparing, automated management of requirements and constraints, integration of dissimilar automated design tools, and multi-media communication.

Phase I: Formulate enabling technologies for CE and study their validity and utility.
Phase II: Demonstrate the feasibility and key features of the technologies formulated in Phase I.

DARPA 92-157 TITLE: Ceramic Fiber Development

CATEGORY: Exploratory Development

OBJECTIVE: To develop low-cost manufacturing methods for ceramic fibers with properties suitable for use in advanced metal and ceramic matrix composites.

DESCRIPTION: Ceramic fiber/metal matrix and ceramic fiber/ceramic matrix composites have been identified by DoD as important to the development of advanced military systems. Widespread use of components made from these composites will depend upon the availability of low-cost/high-performance fibers. For thermostructural applications of interest to DARPA, fibers must maintain high strength and creep resistance at temperatures up to 1500^{o}C. Innovative methods capable of producing weavable fibers (usually having fiber diameters of about 20 microns and below) are of particular interest.

Phase I: Demonstrate a bench-scale process capable of producing fibers with the desired high temperature creep and strength properties.

Phase II: Produce a pilot plant scale-up of process to produce material for characterization and evaluation and to determine ultimate manufacturing costs.

DARPA 92-158 TITLE: Surface Strengthening of Advanced Structural Ceramics

CATEGORY: Exploratory Development

OBJECTIVE: To evaluate methods to increase the bend strength of advanced structural ceramic components utilizing either surface compressive stresses or surface layers with high fracture toughness.

DESCRIPTION: Pressure densification of structural ceramics (or carefully prepared pressureless sintered ceramics) can result in materials with extremely small volume flaws such that bend strength fracture origins are related to surface defects. Significant enhancement of bend strength is expected for this class of ceramics if compressive stresses sufficient to prevent growth of surface flaws is applied, or if high fracture toughness surface laminates are applied. These approaches, combined with post-machining heat treatments to heal surface flaws, should result in significant enhancement of useful strength. The proposal should identify the method for generating surface compressive stresses or applying surface laminates. For components with compressive surface stresses, the effect of temperature and pressure on the surface compressive stress should be evaluated; the stress profile resulting from the compressive strengthening method chosen for evaluation should be determined and an estimate of the magnitude of the strength increase to be expected should be given. Surface strengthening mechanisms which continue to operate at high temperature and can be used with components having complex geometries are of greatest interest.

Phase I: Produce samples with surface compressive stresses or high fracture toughness surface laminates which can be evaluated in four-point bending, using a standard MIL spec bend bar test. Commercially available materials may be used if compatible with the proposed surface modification method proposed. Samples with optimized strengthening will be evaluated for surface flaw sensitivity using controlled flaw technique.

Phase II: Identify, fabricate, and evaluate components of interest to DoD with significant surface stresses in use to demonstrate the capability and utility of the surface strengthening method chosen.

DARPA 92-159 TITLE: Wavelet-based Methods for Partial Differential Equations (PDE)

CATEGORY: Basic Research

OBJECTIVE: To advance computational capability for large-scale problems using wavelet-based methods.

DESCRIPTION: Wavelets and multiscale analysis have shown capabilities to solve many problems in signal processing. The implications for wavelets in the numerical solution of large-scale problems in scientific computing

and simulation are largely unexplored. This solicitation seeks novel approaches to computing suggested by the wavelet paradigm, with its focus on multiscale analysis and sampling. While the focus of this solicitation is on the development of a framework and algorithms for numerical solutions of partial differential equations using wavelets, proposals should address the solution of a problem or class of problems of interest to DoD. The approach should take advantage of high-performance parallel computing where appropriate. Proposals should clearly demonstrate the reasons for choosing the given approach and make clear the potential benefits.

Phase I: Develop general framework and algorithms for solution of a large-scale problem or class of problems of interest to DoD using wavelets.

Phase II: Develop codes and demonstrate efficacy of approach. Results should include comparisons with other approaches (and against experimental data if appropriate).

DARPA 92-160 TITLE: Nonstandard Control Theory for Manufacturing Processes

CATEGORY: Exploratory Development

OBJECTIVE: To develop a control theory and software tools applicable in complicated manufacturing and/or materials processing environments.

DESCRIPTION: Many of the manufacturing and materials processes are too complicated for standard control techniques. The processes are complicated, inherently nonlinear, and composed of parts whose dynamics may be described by models ranging from partial differential equations to discrete systems. This solicitation seeks development of a robust control theory applicable to a broad class of applications in manufacturing or materials processing. The approach should include the use of local simulation or compute automated methods for control design in manufacturing environments where standard techniques are inadequate. The final goal should be to demonstrate techniques on a process of current interest to DoD.

Phase I: Select an approach, choose a target application of interest to DoD, and develop theory applicable to chosen application which will lead to software tools for control design and/or implementation.

Phase II: Apply the approach to chosen process. Develop, as appropriate, software tools for control design and/or implementation, as well as environments for developing controls.

DARPA 92-161 TITLE: Automatic Target Recognition Using Wavelets

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel algorithms for automatic target recognition using wavelets to extract and classify features of interest.

DESCRIPTION: The advent of wavelets and other recently developed transforms greatly broadens the class of tools available for signal processing tasks like automatic target recognition. Traditional approaches are based upon extracting features, using tools like the fast Fourier transform, to produce a small number of feature sets which are postprocessed for detection/classification. This solicitation seeks novel developments to design feature extraction and classification together, employing wavelets and other recently developed transforms. Fusion of information, both from various transforms and multiple sensors, is an important issue. DARPA seeks theory and computational algorithms, targeted at an appropriate computational platform, to radically improve our ability to perform automatic target recognition.

Phase I: Develop an approach, select the appropriate feature extraction tools (which should include wavelets and other recently developed transforms), and outline methods for automatic detection/recognition.

Phase II: Develop algorithms on an appropriate computational platform, and demonstrate performance of algorithms on a realistic problem of interest to DoD.

DARPA 92-162 TITLE: Coupling of Quasi-Continuous Wave (Quasi-cw) Diode Lasers to Optical Fibers

CATEGORY: Exploratory Development

OBJECTIVE: To couple optical fibers to quasi-cw diode lasers to produce high brightness pump sources for solid state lasers.

DESCRIPTION: Fiber coupled semiconductor lasers permit the separation of pump sources and the solid state laser gain medium. Fiber coupling of cw semiconductor laser sources has been successfully demonstrated. This technique is used in several cw solid state laser system designs. Extension of this technique to quasi-cw semiconductor lasers is needed to produce high brightness pump sources for solid state lasers.

Phase I: Demonstrate efficient fiber coupling of a single bar of quasi-cw semicondutor lasers and demonstrate high brightness output.

Phase II: Extend the techniques developed in Phase I to fiber couple multiple stacks of quasi-cw semiconductor lasers and demonstrate efficient end pumping of solid state lasers.

DARPA 92-163 TITLE: Planar Nonlinear Optical Devices

CATEGORY: Exploratory Development

OBJECTIVE: To develop nonlinear optical devices using planar fabrication techniques and integration with semiconductor lasers.

DESCRIPTION: Nonlinear optical devices such as nonlinear frequency converters, beam deflectors and switches integrated with semiconductor laser sources are important for applications in optical communication and data storage, displays and sensor systems. These devices can be fabricated in planar form and integrated in a compact monolithic structure to perform more than one function. The progress in epitaxial growth technologies together with lithographic patterning opened new approaches to materials growth and device configurations that can be manufactured at low cost.

Phase I: Analyze the material growth approaches and device concepts to integrate planar nonlinear optical devices semiconductor lasers.

Phase II: Demonstrate the concepts developed in Phase I and optimize the performance for applications.

DARPA 92-164 TITLE: Novel Applications of Cold Field Emitters

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel applications of high brightness cold field emitters.

DESCRIPTION: Field emitter arrays (FEA) have made tremendous advances in recent years. Emitter size is down to sub-micron, and emitter current can be as high as 500 micro amp. per tip. Both the lifetime and reliability of FEA have improved a great deal -- lifetime in the range of thousands of hours is not uncommon. Emitters also come in all types and shapes: cones, edges, trenches, pyramids, and thin films. In view of all these developments, there are ongoing efforts trying to apply this technology to radio frequency (RF) generation and high-definition displays. More innovative ideas are needed in applying this technology. Special effort should be made in identifying a final system.

Phase I: Submit preliminary design of application. If it is an improvement of an old system, then an estimate of the magnitude of improvement is desired. If it is new, then an estimate of the performance should be given.

Phase II: Conduct proof-of-principle demonstration of application.

DARPA 92-165 TITLE: Applications of Fullerene Chemistry

CATEGORY: Exploratory Development

OBJECTIVE: To explore the possibility of developing useful technological applications involving the use of fullerenes such as C-60.

DESCRIPTION: Fullerenes form a series of new allotropes of carbon that have a variety of fascinating properties. Proposals are sought to identify and demonstrate the feasibility of using fullerenes in novel applications. Other issues, such as the investigation of fundamental properties and structure, synthesis and purification, chemical reactions, electrochemistry, conductivity, and the superconductivity of these materials, as they relate to the intended application, should also be addressed in the proposal.

Phase I: Demonstrate the feasibility and utility of using fullerenes in the intended application.

Phase II: Test the performance of these novel materials in the intended application.

DARPA 92-166 TITLE: Novel Hydrogen Storage Materials for Fuel Cell Applications

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate novel hydrogen storage materials to be used as alternatives to cryogenic hydrogen in fuel cell applications with improved performance.

DESCRIPTION: Several types of fuel cells are capable of operating efficiently using hydrogen as a fuel source. Cryogenic hydrogen is often used to maximize the energy density of the system. However, there are a number of drawbacks to this approach with respect to safety and the storage complexity of the liquid hydrogen. Proposals are sought with ideas for novel materials and approaches to the hydrogen storage problem which offer the possibility of improved performance over the more conventional approaches (such as metal hydrides) which are currently used. Compatibility of the new materials with fuel cell operation, catalyst poisoning, toxicity, economics, logistics, processibility, regeneration, storage, stability, and shelf-life are some of the other factors which should be addressed in the proposal.

Phase I: Identify, produce, and test a promising candidate hydrogen storage materials/system.

Phase II: Incorporate a candidate storage system in a fuel cell and evaluate its performance.

DARPA 92-167 TITLE: Tools for Multi-Chip Modules (MCM) with Superconducting Interconnects

CATEGORY: Exploratory Development

OBJECTIVE: To develop new tools to optimize routing in the utilization of superconducting interconnects of MCM.

DESCRIPTION: The reduction of interconnect linewidth, possible with patterned superconducting films in MCM packages, leads to great simplification, particularly for high integrated circuit chip density. Optimal routing cannot be accomplished with standard computer-aided engineering and computer-aided design (CAE/CAD) tools, and new strategies must be developed.

Phase I: Develop routing procedures for superconducting interconnects in microstrip and coplanar configurations.

Phase II: Develop CAE/CAD tool for routing superconducting interconnects and demonstrate for test cases.

DARPA 92-168 TITLE: Optimization of Cryoelectronic Performance in Complementary Metal-Oxide Semiconductor (CMOS)

CATEGORY: Exploratory Development

OBJECTIVE: To improve the performance of CMOS integrated circuits (ICs) at 80K (liquid nitrogen temperature) and display enhanced performance at cryogenic temperatures. CMOS ICs display enhanced performance at cryogenic temperatures, and analysis is needed to guide small changes in the fabrication process which would further enhance performance.

DESCRIPTION: The optimization of standard CMOS ICs for operation at cryogenic temperature (80K), under the condition of minimum deviation from design rules in processing and fabrication of IC chips, will require changes of

implant density and channel width. A basic analysis is needed to understand the sensitivity of IC operation to such changes.

Phase I: Demonstrate a method for understanding and optimizing the performance of CMOS ICs at cryogenic temperature.

Phase II: Apply optimization procedures to the production of demonstration ICs and test for increased performance.

DARPA 92-169 TITLE: Molecular Materials

CATEGORY: Exploratory Development

OBJECTIVE: To design and synthesize advanced molecular materials and fabricate molecule-based components and devices.

DESCRIPTION: Important fundamental progress has been made in the synthesis of materials whose bulk or thin film properties are determined by the rational, purposeful manipulation of species at the molecular level. Most commonly, manipulation is effected: (1) by the innovative selection of the basic molecular building blocks themselves; (2) by learning to control the ordering of such component molecules to influence the structure, stability, and derivative properties of the supramolecular assembly; or (3) by exploiting sub-micron scale templates for the subsequent linkage of subsidiary molecular moieties, where the template's innate structure and morphology may impute yet additional desirable physical or chemical properties. Proposals are sought which: (1) deal with the efficient synthesis of novel molecular materials; and/or (2) focus on the design and fabrication of such molecule-based components and devices. Offerors should be careful to describe plausible devices or applications and discuss the anticipated performance enhancement to be realized from utilization of molecular materials, in light of generally competing alternative technologies.

Phase I: Develop proposals which identify novel methodological concepts and focus efforts on central research issue(s) with reasonable technical progress.

Phase II: Provide initial proof-of-concept demonstration.

DARPA 92-170 TITLE: Biological Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To exploit the results of recent studies of walking, swimming, and flying organisms to enhance the capabilities of man-man surveillance and communications systems.

DESCRIPTION: Evolutionary pressures impacting living organisms have led to the development of extraordinary sensory and perceptual systems insuring success in diverse (i.e., land, air, sea) environments. We know a great deal about the sensory mechanisms themselves (e.g., photoreceptors, acoustic detectors, etc.), and are starting to make significant progress in characterizing the means by which living organisms extract and integrate the wealth of information they obtain. It is expected that further success would permit: (1) the development of more robust signal processors that are selectively sensitive to information-bearing channels and simultaneously robust relative to distractions and distortions; (2) the realization of multi-channel sensory fusion combining information from multiple dimensions and multiple channels to form unified representations of complex objects; (3) optimal designs for communication signals and for allocation of effort in response to demands, needs, resources, and threats; (4) expectation guided signal detection and target anticipation; and (5) methods for optimal data presentation. Proposals are desired: (1) which seek to implement significant inferred or derived strategies in hardware/software, and/or (2) which intend to evaluate the potential impact on military systems of alternative strategies where substantial and significant experimental and analytical work has already been completed at the level of the living organism. For purposes of this solicitation, proposals that focus (narrowly) on the use of artificial neural networks are discouraged.

Phase I: Develop proposals which identify novel methodological or technological concepts, and focus efforts on central research issue(s) with reasonable technical progress.

Phase II: Provide initial proof-of-concept demonstration.

DARPA 92-171 TITLE: Smart Materials and Structures

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate a new class of materials which have the capability to both sense and respond to environmental stimuli, and which have the capability of active control of their response.

DESCRIPTION: Smart materials offer many enhancements and new capabilities to DoD systems, particularly in performance durability and reliability. Smart materials can provide designers and engineers with significant new capability to control geometric shape, structure movement, damping and vibration absorption, and other attributes as designed properties of the material. The proposed program should provide for the development of new materials with active constituents which can be controlled. These materials can be designed to react to external stimuli on either a micro-mechanical or macro-mechanical level. The development of functional adaptive materials, along with advances in theory, sensors, actuators, control algorithms, and signal processing as applied to smart materials, is of interest.

Phase I: Develop basic theory and proof-of-concept in areas of sensors, actuators, composite design, matrix and reinforcement selection, information management and architecture, and control systems as applied to an integrated smart material or as individual topics which have potential applicability to smart materials.

Phase II: Develop smart materials and structures characterization, calibration, and validation.

DARPA 92-172 TITLE: Silicon-Germanium Digital Integrated Circuit Development

CATEGORY: Exploratory Development

OBJECTIVE: To exploit the performance advantages of silicon-germanium (Si-Ge) to develop higher performance digital integrated circuits. Both bipolar and field effect transistor circuits are of interest.

DESCRIPTION: DoD systems require an increasing ability to process very large amounts of data in a short time. Bipolar transistors with small amounts of germanium added (primarily) to their base regions have been shown, at room temperature, to have cutoff frequencies approximately twice as high as those of transistors with identical geometries but fabricated entirely from silicon. Field effect transistors with p-type silicon-germanium channels have considerably higher hole mobilities than similar devices with channels made completely from silicon. If silicon-germanium circuits can be produced with reasonable yields, they can be directly substituted for all silicon circuits of the same design but with the advantage of considerably increased performance. What remains to be done is: (1) the development of large-scale integrated (LSI) or very large-scale integrated (VLSI) circuits using this materials combination; (2) transition of the technology from R&D to manufacturing; and (3) an assessment of long-term reliability.

Phase I: Propose LSI or VLSI circuits of DoD interest for fabrication using silicon-germanium material for active circuit region. Develop a comprehensive plan for producing these circuits, including material selection and source, design modifications (if necessary) from existing silicon material based designs, fabrication approach, and packing and testing methodology.

Phase II: Fabricate sample quantities of selected circuit types and compare performance with that of similar circuits fabricated from silicon.

DARPA 92-173 TITLE: Intelligent Test of Advanced Multi-Chip Modules

CATEGORY: Advanced Development

OBJECTIVE: To develop novel tools and methods which aid in the design and test of complex multi-chip modules.

DESCRIPTION: Due to their high operating speeds, incorporation of multiple technologies, varying design approaches, and lack of accessibility to internal circuit nodes, current multi-chip modules (MCMs) are inherently complex to design and difficult to test. Fundamentally new approaches and tools are needed for both the design of

chips and MCMs, as well as for the testing of MCMs assembled out of chips obtained from multiple sources. Approaches toward design must be driven by cost, performance, functional density, and ease of test/verification. Approaches to test should include detection of defects in the bare die, and accommodate mixes of circuit type (memory, logic, ASIC, linear) and technology and design-for-test (DFT) strategies within the same MCM. Topics of interest include, but are not limited to, computer-aided design and test tools, die and substrate DFT tools, test equipment, built-in-self-test, bare die burn-in and test, MCM substrate test, and final module test. Design tools must be able to deal with multiple chip and MCM substrate technologies and should be easily integrated into chip and board design environments.

Phase I: Define a detailed specification for the new approach or tool to be developed. Describe new and innovative ideas which will provide new capabilities for MCM design and test. Develop a plan to demonstrate the utility of this capability in the design of an actual system in collaboration with an MCM foundry. As appropriate, demonstrate key elements with prototypes. Prepare a business plan to ensure commercial availability.

Phase II: Develop and demonstrate the prototype software or approaches defined in Phase I.

DARPA 92-174 TITLE: Phosphors for Display Applications

CATEGORY: Exploratory Development

OBJECTIVE: To identify and prepare phosphor materials that improve display performance.

DESCRIPTION: Virtually every display technology uses phosphors. Phosphor applications in displays range from high efficiency, spectrally peaked backlights for liquid crystal displays to direct emission materials in electroluminescent or field emitter devices. Improvements in phosphor performance are directly related to improvements in display brightness, chromaticity, and power consumption. Innovative approaches to optimizing phosphor performance are sought.

Phase I: Identify new phosphor formulations, morphologies, and fabrication processes that enhance display performance. Establish by preliminary experiments the potential advantage of the improved material.

Phase II: Prepare and test the new material in display application.

DARPA 92-175 TITLE: Innovative Color Filter Materials

CATEGORY: Exploratory Development

OBJECTIVE: To reduce the cost and improve the performance of liquid crystal display (LCD) color filter materials.

DESCRIPTION: LCDs employ color filters for generating color images. The color filter assembly is a significant cost fraction of the total display cost. The color filter is also responsible for limiting the brightness of the display. Improvements in filter materials that lead to higher brightness, saturation, long-term stability, and lower cost are sought.

Phase I: Identify new color filter materials or methods of fabricative filters that improve display performance or cost.

Phase II: Fabricate filter assemblies to be tested in display devices.

DARPA 92-176 TITLE: Head and Hand Position Sensors for Use with Head Mounted Augmented Reality Systems

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop, and demonstrate innovative technology/techniques for head and/or hand positioning sensors that could be used in conjunction with head mounted displays in augmented reality systems.

DESCRIPTION: Head mounted display systems require accurate and timely position information to coordinate movements of the head and hand with information displayed to the eye. Current approaches are bulky, heavy, and

inconvenient to use. They frequently require an operator to remain in a stationary position, and therefore limit mobility. Significant improvements are needed in sensor position accuracy, update rates, weight, size, and cost.

Phase I: Review applicable technologies and specify an effective development path for a prototype sensor which addresses the above requirements.

Phase II: Build and test a prototype sensor(s).

DARPA 92-177 TITLE: Eye Tracker Technology for Use with Head Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop, and demonstrate innovative technology/techniques for using eye trackers to remotely access computer databases.

DESCRIPTION: Field operatives of all kinds frequently need to review, consult, or search large bodies of data (manuals, records, files) while conducting their missions. Efficient data access requires a method of computer interfacing which is rugged enough to be used in the field, is relatively unaffected by head and body movement, is pleasant and comfortable to use, and uses the eye as an input device for a head-mounted display.

Phase I: Review applicable technologies and specify an effective development path for a prototype system meeting these requirements. Show the feasibility of this approach.

Phase II: Build and test a prototype system.

DARPA 92-178 TITLE: Low-Cost, Weather-Resistant Photochromic Thin Films

CATEGORY: Advanced Development

OBJECTIVE: To develop rugged, low-cost photochromic thin films for application to field equipment.

DESCRIPTION: Rugged, low-cost photochromic surface coatings are desired for application to exterior surfaces of field equipment. Coatings should be transparent under low-incident light conditions and dark under direct illumination by the sun. Low-surface reflectivity and low glint are desired for both conditions.

Phase I: Conduct studies of property optimization, cost/producibility, and produce a small (6" x 6") sample.

Phase II: Produce and test optimized coatings for ruggedness, weather proofing, cycle aging, and all technical parameters measured. A one-meter square sample will be fabricated and field demonstrated.

DARPA 92-179 TITLE: Diagnostic Techniques to Give Increased Information from Chemical Energy Warhead Tests

CATEGORY: Basic Research

OBJECTIVE: To develop diagnostic techniques to give increased understanding of chemical energy warhead functioning and armor defeat mechanisms.

DESCRIPTION: Due to the highly energetic and dynamic behavior of chemical energy warheads and armor defeat phenomena, there exists a limited set of diagnostic techniques with which to directly observe and measure important performance parameters. It may be useful to observe phenomena through different media, or to observe heretofore unseen mechanisms in warhead performance and armor defeat. There may also exist conventional diagnostic techniques for which the data analysis is not well developed or the full versatility of the technique is not realized by the community. Responses to this topic should concentrate on the development of diagnostic techniques which give an increased understanding of aspects of chemical energy warhead functioning and/or armor defeat mechanics, with a clear explanation of what parameters will be measurable and/or observable and how this information will benefit warhead design.

Phase I: Develop the novel diagnostic technique and demonstrate its utility in furthering the understanding of chemical energy warheads. If the required hardware is currently available, limited range testing of

actual warheads may be appropriate. Otherwise, this phase should concentrate on hardware and technique development with the goal of demonstrating the technique in some laboratory testing fashion.

Phase II: Demonstrate the technique from Phase I in an actual warhead test and evaluation range environment on a candidate chemical energy warhead. The objectives of the testing will be to use this diagnostic technique to extract the relevant information for which it was developed.

DARPA 92-180 TITLE: Burning Rate Catalysis of Ammonium Nitrate (AN) Propellants

CATEGORY: Exploratory Development

OBJECTIVE: To improve smokeless, insensitive propellants for rocket motors.

DESCRIPTION: Insensitive Munition (IM) propulsion systems which will address combat/storage/transportation threats are required for future Army tactical missile systems. High-performance, minimum-signature propellants for current operational tactical Army missiles are Class 1.1 detonable explosive materials. Rugged nondetonable Class 1.3 AN propellants have been developed to meet IM and minimum signature requirements. These AN propellants have low burning rates. Burn-rate catalysts which will not degrade motor plume signature, IM, or stability properties are not available at this time. New methods to catalyze these minimum signature IM AN propellants to a minimum 0.50 inch/second and a pressure exponent <0.5 are needed.

Phase I: Evaluate the feasibility of proposed concepts and provide detailed analysis supporting conclusions. Conduct preliminary laboratory experiments which demonstrate concept feasibility.

Phase II: Demonstrate full-scale concepts through construction and firing of small rocket motors which demonstrate the required characteristics.

DARPA 92-181 TITLE: A High Yield Synthesis Process for Ammonium Dinitramide (ADN)

CATEGORY: Basic Research

OBJECTIVE: To develop a new high-yield synthesis process for ADN.

DESCRIPTION: ADN is a promising new inorganic oxidizer for propellant compositions discovered by Dr. Robert Schmidt, SRI. However, the current synthesis yield is low (15%) and, therefore, the cost/pound is high. Oxidizers typically comprise over 70% of propellant formulations. A new, inexpensive synthesis procedure or processing technique with yields above 75%, and high purity, is needed for ADN to be a practical material for propellants.

Phase I: Demonstrate a process which has potential for growth and which can be made to yield at least one pound of material per batch at a yield of 65 to 70%. The purification process should be well defined and capable of expansion to larger batches.

Phase II: Demonstrate a pilot facility and process at the level of 10-15 pound batches which produces spherical crystals.

DARPA 92-182 TITLE: Quasi-Optical Injection Locking Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To analyze, in-depth, injection locking techniques for use in quasi-optical millimeter-wave oscillator arrays.

DESCRIPTION: Quasi-optics describes the extension of optical techniques down to the millimeter-wave spectrum. Quasi-optical millimeter-wave oscillator power combining consists of locking an array of oscillators to a particular resonator mode of a Fabry-Perot resonator. Since there are generally numerous axial modes in the resonator which correspond to slightly different resonant frequencies, external injection locking techniques are required to ensure a particular coherent oscillator frequency as well as a stable mode of oscillation. This study will investigate various techniques for externally injection locking the oscillator array to a particular axial mode of the resonator. The injection locking power requirements to maintain a stable lock and to change frequency will be studied as a function of array size and resonator parameters. Efficient and non-interfering methods for coupling in the injection locking

signal will also be investigated.

Phase I: Investigate injection locking power requirements and techniques. Deliverables will include reports and a description of any computer codes utilized.

Phase II: Conduct experimental demonstration of the injection locking techniques proposed in Phase I. Deliverables will include reports and experimental hardware.

DARPA 92-183 TITLE: Quasi-Optical Power Combiner Modeling

CATEGORY: Exploratory Development

OBJECTIVE: To develop models and algorithms for predicting performance of quasi-optical millimeter-wave oscillator arrays combined in Fabry-Perot resonators.

DESCRIPTION: Quasi-optical open resonator power combining refers to combining solid-state devices in a Fabry-Perot resonator. Quasi-optical power combining offers the potential for achieving high power in small packages by efficient power combining of 2 and 3 terminal millimeter-wave solid-state sources. Realization of this potential requires a better understanding of the device-resonator interaction and loaded resonator electromagnetic propagation phenomenon through analytical modeling. The models developed under this investigation should be applicable for assessing power combining efficiency, DC-RF conversion efficiency, and transient and spectral properties of the combiner as a function of the device and resonator parameters. The models should provide insight into optimum oscillator array design by simulating the interrelationship between device spacing and driving-point impedance. The oscillator array will consist of three terminal devices and either a grid or active antenna configuration may be considered for the device array.

Phase I: Develop mathematical models and algorithms for predicting combiner performance. Deliverables will include reports and any computer codes utilized.

Phase II: Refine models and algorithms. Verification of the predicted performance will be demonstrated through experimental studies. Deliverables will include reports, computer codes, and experimental hardware.

DARPA 92-184 TITLE: Up/Down Sensing Using the Atmospheric Electric Field and Infrared Sensing

CATEGORY: Basic Research

OBJECTIVE: To develop a reliable method for determining the orientation of an object in flight, such as a missile, using the atmospheric electric field potential.

DESCRIPTION: The atmospheric electric field near the earth's surface is typically 100 volts per meter and is orientated vertically so that positive charges are driven downward toward the earth. If this constant and directional potential can be detected and measured reliably, it should be possible to determine the position relative to the ground of a spinning projectile. Infrared sensors for detecting the ground or the sky could also be added for additional sensing. This system could be a more cost-effective up/down sensing method than the currently used gyros.

Phase I: Design and build a prototype capable of measuring the atmospheric electric field and detecting the position relative to the ground of an object when the object is rotated about an axis horizontal to the earth's surface.

Phase II: Refine the design of Phase I and build a device for inclusion in a flying, spinning projectile. Demonstrate through actual flight tests the ability to know the real-time orientation of the spinning object. Demonstrate the ability to use the method decided upon in Phase I for up/down sensing in a variety of missile systems and missile flight conditions.

DARPA 92-185 TITLE: Device to Passively Remove Water From Air Lines

CATEGORY: Basic Research

OBJECTIVE: To develop a reliable, passive method for removing water from air lines which deliver compressed

air. The method cannot require frequent, periodic maintenance such as filter replacement or draining.

DESCRIPTION: When air is compressed the relative humidity of the air increases. If the compressed air's relative humidity exceeds 100%, a condensate forms. The resulting water droplets travel on the walls of the pipe or hose to the equipment being operated by the compressed air. This liquid water is usually undesired. For example, in a paint sprayer, the water may cause spotting in the sprayed paint. Also, an air driven power tool or air turbine will become wet and drip water in a short time. Water traps and filters are normally used to remove the water, but these devices require periodic maintenance which is frequently neglected.

Phase I: Design a device that can be added in line with a compressed air hose and removes the water droplets without having to be replaced or removed for maintenance. Support the feasibility of the design with calculations and test data.

Phase II: Refine the design and prototype of Phase I. Demonstrate the device's ability to successfully remove water from a wide range of air line lengths, diameters, and air pressures. Also, test the device under a range of ambient air temperatures and humidities. Deliver 20 devices.

DARPA 92-186 TITLE: Ultra Low-Cost Turboprop for RPV/UAV Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate an ultra low-cost turboprop engine for Remotely Piloted Vehicle/Unmanned Aerial Vehicle (RPV/UAV) applications.

DESCRIPTION: A number of current generation short-range RPVs and UAVs employ propulsion systems that utilize a reciprocating engine driving a propeller. The use of a reciprocating engine-based power plant has several significant shortcomings:

a. Current off-the-shelf engines require gasoline as a fuel, which presents an obvious safety hazard as well as a logistics problem (gasoline-powered vehicles are scheduled for elimination from the U.S. inventory).

b. Cold weather starting is a severe problem.

c. The maximum operating altitude is extremely limited.

d. Available engine horsepower density severely limits vehicle flight speeds.

The obvious means of overcoming the significant deficiencies associated with the current RPV/UAV propulsion systems is the incorporation of a turboprop power plant. The design, development, and fabrication of an ultra low-cost RPV/UAV turboprop propulsion system is desired. The turboprop engine to be developed must be based on one of the currently available low-cost expendable turbojet engines (previously developed for missile applications) in the 4.0 to 8.0 inch diameter class (50 lbf to 200 lbf thrust class). The turboprop engine design approach must incorporate a propeller propulsion module which integrates directly with the existing turbojet exhaust. The components of the existing turbojet will be utilized to a maximum extent and modifications to the gas generator engine will be minimal. The design will place emphasis on low-cost simplicity and low weight. No specific performance goals are stated, but thrust should be maximized and specific fuel consumption minimized within the practical constraints of low cost.

Phase I: Design, fabricate, and deliver a heavy-wall turboprop propulsion unit (including propeller, drive system, exhaust system, and hardware for integration with the turbojet) for immediate integration with a Government-owned turbojet. The turbojet module must be adaptable to either the Williams International Model P8910 or the Sunstrand Power System Model TJ-90 turbojets. If the contractor desires to integrate the turboprop propulsion unit with an existing turbojet other than the P8910 or TJ-90, a functioning turbojet engine must also be delivered. If the turboprop system requires a control system that is independent of the turbojet fuel control, a static test control system must also be delivered.

Phase II: Design, fabricate, and deliver a flight-weight turboprop RPV/UAV propulsion system, including turbojet gas generator, propeller drive system, fuel control, and fuel tankage. The system will be

delivered to the Government for evaluation testing.

DARPA 92-187 TITLE: Ultra Low-Cost Fuel Tankage for Expendable Turbojet Propulsion Systems

CATEGORY: Advanced Development

OBJECTIVE: To develop an ultra low-cost fuel tankage system for turbojet powered tactical missiles.

DESCRIPTION: Low-cost expendable turbojet engines have been developed as the sustainer propulsion system for extended range tactical missiles. Technology is required to provide ultra low-cost fuel tankage systems for turbojet powered missiles. The design, development, fabrication, and delivery of fuel tankage systems suitable for integration in the Long Range Fiber Optic Guided Missile (LONGFOG) airframe is desired (interface and fuel capacity requirements are available on request). The tankage system must be comprised of two components: an external structure/pressure vessel and an inner fuel bladder. The system will be designed to provide fuel to the turbojet engine under two modes of operation: via direct expulsion utilizing compressor discharge air pressurization, or via vacuum expulsion using the suction head of a positive displacement fuel metering pump. The system must be designed for 10-year storage of JP-10 fuel in the Army Tactical Environment. Innovative fabrication techniques and material selections are encouraged. The utilization of injection molded plastics for the external shell and low-cost mylar or plastics for the bladder should be investigated. Materials and technologies used in the food packaging industry should be investigated.

Phase I: Design, develop, fabricate, and deliver a prototype, non-production tankage system. The system must be delivered to the Government for integration in the LONGFOG airframe and turbojet engine static operation evaluation.

Phase II: Design, development, production, and qualification of a production tankage system. Several fuel tankage systems must be fabricated utilizing production materials, tooling, and processes. The system will be qualification tested. Ten (10) systems will be delivered to the Government for flight vehicle utilization.

DARPA 92-188 TITLE: Flexible Circuit Reliability Enhancements Using Pulsed Magnetic Treatments

CATEGORY: Basic Research

OBJECTIVE: To investigate innovative methods of removing fatigue stresses from flexible circuits, cables, and interconnects.

DESCRIPTION: Flexible circuits are used extensively in military hardware to provide compact, movable interconnections between electronic subassemblies. Recent experiments have shown that pulsed magnetic treatments on diamagnetic materials such as copper have removed some of the internal metallurgical defects. If these treatments can remove the fatigue stresses from military flexible wire harnesses, the likelihood of opens and signal losses in the cabling may be reduced, improving system reliability.

Phase I: Evaluate methods of "magnetically annealing" the mechanical stresses in flexible copper printed circuits. Perform tests to determine levels of magnetism required to "heal" metallurgical defects and level of "healing" obtained. Perform a cost study to determine potential applications and reliability/cost improvements if applied to military and commercial hardware.

Phase II: Conduct accelerated life cycle tests on treated and untreated cable to determine correlation between pulsed magnetic treatments and increased circuit life. Develop methods that are as non-invasive as possible for treatment during cable manufacture, cable installation, and field maintenance.

DARPA 92-189 TITLE: Applications of Binary Optics in Missile Systems

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the benefits of binary optics by insertion into a weapon subsystem.

DESCRIPTION: Binary optics promises a second revolution in optics through the marriage of microelectronics and

microoptics. Through this marriage the manufacturing process technology of microelectronics can be applied to produce optical components that perform the functions of conventional components as well as components that perform functions that cannot be realized with conventional optics. Examples include lenses 1/40th the thickness of this page and arrays of 10,000 tiny telescopes, each approaching the diameter of a human hair. The technology thus has the potential to improve performance and reduce cost and weight of optical military systems and subsystems.

Phase I: Demonstrate the benefits of the technology through technology insertion into an existing representative optical system to be selected by the contractor. The contractor will then conduct a manufacturing process analysis and select the optical element for production in binary optics form.

Phase II: Establish the statistical spread of the manufacturing process by fabricating and characterizing a series of binary optical components in the laboratory, and then inserting them in the selected optical system for benefits comparison with conventional optics.

DARPA 92-190 TITLE: End-Fire Element Ring Antenna With Integrated T/R Module

CATEGORY: Exploratory Development

OBJECTIVE: To develop a wide bandwidth, end-fire element, ring antenna that would fit conformably on a 5.85 inch diameter missile that is integrated with a Transmit and Receive Module.

DESCRIPTION: In order to meet high-velocity and maneuverability requirements, many missile systems on the drawing board today cannot use traditional wire guidance. Thus, other data transmission methods must be used. The most versatile transmission method is a Radio Frequency (RF) data link. However, antenna placement is critical for aerodynamic reasons. The problems of antenna placement also apply to a variety of RF sensors. A wide bandwidth, end-fire element, ring antenna with an integrated transceiver (T/R Module) offers the advantages of excellent aerodynamics with small volume and weight. The importance of wide bandwidth is to allow flexibility in the use of a variety of data link and RF sensor systems. Innovative ideas are sought for the design and implementation of the ring antennas with feed assembly and an integrated transceiver, operating in Ku band (with a bandwidth of at least 10%), one at Ka band (with a bandwidth of at least 7%), and one at W band (with a bandwidth of at least 3%). The output of the transceiver should be an IF (Intermediate Frequency) signal in the 10 to 100 MHz (Mega-Hertz) range. Proposals should contain detailed analysis and description of the design of the antennas, feed assembly, and transceiver, as well as a detailed analysis and description of the integration and implementation of the complete package. Emphasis will be placed on techniques which produce the lowest cost antenna, feed assembly, and transceiver integrated in the smallest volume.

Phase I: Provide detailed analysis of the proposed design, including experimental evaluation plan.

Phase II: Develop hardware and perform laboratory demonstrations to verify the technical approach.

DARPA 92-191 TITLE: Hybrid Filament Winding/Molding Fabrication Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop a fabrication process that utilizes the advantages of filament winding without restriction that the components be bodies of revolution.

DESCRIPTION: Filament wound composite fabrication techniques produce extremely strong structures. Limitations due to the nature of the process require that the structures be bodies of revolution or close approximations. Molded structures have fewer limitations on their shape and can be much more complex. Molded structures do not have the strength of a filament wound part. A technique that can produce a structure with complex features yet have the strength of a filament wound part is desirable. An example would be a cylindrical or rectangular section with flat plate extensions along the longitudinal axis, with a height at least one-third the diameter. These extensions would perform much the same function as stiffeners.

Phase I: Design a preliminary process that would have the potential of increasing the structural characteristics of the cylinder or rectangular cross-section described above. Strength and stiffness are the primary properties of concern, with stiffness being most critical.

Phase II: Fabricate and test the structure designed in Phase I. The demonstration would include a

comparison of stiffness and strength between a filament wound structure and a hybrid structure. Considerations would also be needed for low-cost production.

DARPA 92-192 TITLE: High-Strength Molding Techniques/Components

CATEGORY: Exploratory Development

OBJECTIVE: To develop molded parts with higher strength, in particular, tensile strength.

DESCRIPTION: Molded parts are attractive to designers due to their low cost, ease of fabrication, and high production rate capability. One of the main drawbacks to molding is the low strength of molding compounds, particularly when compared with the strength of composite layups. The lower strength has prevented the use of molded parts in many applications. There exists a need for molded parts with strengths significantly greater than currently available. Higher strength can be achieved by process change or material change, while retaining the ability to mold complex parts.

Phase I: Perform preliminary studies of different processes and/or materials that would significantly increase the strength of a molded part. A sample part would also be designed with a shape that can be easily tested, but with some complex features.

Phase II: Fabricate and test the sample part designed in Phase I to verify the process/material. The strength and ease of fabrication would be the main considerations in determining the success of the molded part.

DARPA 92-193 TITLE: Development of Metrology Technology for In-Process Measurements in Sub-0.25 Micron Lithography Cluster Tools

CATEGORY: Basic Research

OBJECTIVE: To develop metrology hardware and algorithms which interface with cluster semiconductor manufacturing tools for sub-0.25 micron geometries.

DESCRIPTION: The development of cluster-based semiconductor manufacturing tools and the reduction of device critical dimensions to below 0.25 microns will require novel techniques for the measurement and control of critical process parameters. In particular, this program will develop contact and non-contact methods of measuring device critical dimension and overlay with accuracy below 20 nm and precision below 10 nm. These metrology solutions will be coupled to the cluster tools to provide real-time process centering, yield enhancement, and compatibility with high-volume fabrication techniques.

Phase I: Define a traceable metrology for determining the line width and overlay accuracy of integrated circuit geometries by contact or non-contact techniques. The proposed approach will include small integrated device test structures and a recommended metrology hardware solution. The recommended approach will be compatible with cluster-based manufacturing and will be evaluated for projected performance limitations, process and tool integration, throughput limitations, and impact on device yield.

Phase II: Demonstrate a prototype metrology cell which is coupled to a cluster-based lithography tool and demonstrates an integrated process solution for sub-0.25 micron lines. The demonstration cell will incorporate a method of on-line measurement feedback for process analysis and yield prediction.

DARPA 92-194 TITLE: Compact, Low-Cost, Scalable X-Ray Sources for Proximity and Projection X-Ray Lithography Applications

CATEGORY: Advanced Development

OBJECTIVE: To develop X-ray sources for proximity and projection lithography applications. The sources should meet the requirements for semiconductor device production, including characteristics such as size, cost, reliability, X-ray spectrum, throughput, etc.

DESCRIPTION: The semiconductor industry is characterized by the continuing trend toward smaller feature sizes

in the semiconductor device structures. One path to achieving smaller features is to decrease the wavelength of the exposing radiation. Current approaches to X-ray lithography include proximity and projection methods, using wavelengths in the range of 1 and 13 nanometers, respectively. Future utilization of these technologies will be enhanced by the availability of lithography tools with size, cost, and throughput parameters similar to those optical equipments currently used in production. Synchrotrons lack the small size and small capital investment required for facilities with low-volume production. The sources should provide X-rays of wavelength and collimation compatible with the chosen approach, and at an intensity compatible with resist sensitivities and exposure fields to produce throughput in the range of 60 wafer levels (200 mm) per hour.

Phase I: Identify an approach which offers improved source characteristics, evaluate technology base against needs, and detail a plan to develop and demonstrate a prototype.

Phase II: Build and characterize a prototype and detail a plan to integrate into lithography tool.

DARPA 92-195 TITLE: Stage Control and Alignment Techniques for Advanced Lithography/Metrology

CATEGORY: Exploratory Development

OBJECTIVE: To develop technology for controlling and measuring positioning, either relative or to a perfect grid, of stages for masks and wafers in semiconductor lithography and metrology. The solutions should be extendable to meet the requirements for fabricating semiconductor devices with features in the 0.1 micrometer range.

DESCRIPTION: Trends in the semiconductor industry continue toward smaller feature sizes, giving rise to improved cost and performance for microelectronic components. By the end of the decade, the features for advanced integrated circuits will approach 0.1 micrometers, and the number of masking levels will be in the range of 20-30. These features imply a need for improvements in control of mask-to-wafer alignment during wafer exposure, in absolute positioning during mask writing, in measuring critical dimensions in the local device area, and in two-dimensional measurements across the masks used in reduction lithography. Scanning techniques, used to overcome limitations in large area optics, will stress control and positional accuracy during exposure. Proximity X-ray printing requires control in the mask-wafer gap spacing. New approaches are sought which will address one or more of the problems related to the above issues.

Phase I: Identify approaches which address one or more of these issues, expand the technology base in critical areas, detail a prototype solution, and provide benefits.

Phase II: Construct a prototype assembly and demonstrate its operation, providing evidence for possibility of later integration into alignment or metrology tools.

DARPA 92-196 TITLE: Packaging Optoelectronic Modules

CATEGORY: Exploratory Development

OBJECTIVE: To package optoelectronic modules in order to provide optical input/outputs, electrical input/outputs, and mechanical and environmental stability.

DESCRIPTION: Optoelectronic modules will be used extensively in electronic systems such as computers, radars, and communication links. Proper packaging will provide best performance and compatibility. Considerations should be given to combine requirements in optical, electrical, and mechanical design to achieve optimal performance. Ease of optical alignment is a major consideration. Thermal management also needs to be investigated.

Phase I: Identify specific optoelectronic module as candidate to be packaged. Investigate optimal approaches. Demonstrate that experimentally identified critical barriers were surmounted. List performance goals.

Phase II: Implement Phase I approach, and test and demonstrate expected performance goals.

DARPA 92-197 TITLE: Applications of Artificial Neural Nets to Process Diagnosis and Control

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the utility of artificial neural network methods in diagnostic and control tasks.

DESCRIPTION: Innovative research efforts are sought for demonstrating the utility of artificial neural net methods in process monitoring and control. Proposals must address specific DoD applications. These may include Defense manufacturing, specific hardware systems or subsystems, or large-scale processes such as resource allocation. Preference will be given to proposals that address both monitoring and control. Proposals that address only monitoring or diagnosis are also of interest. Strongest preference will be for proposals that address specific applications with potential for near-term DoD implementation and for which sufficient neural net training and testing data are readily available.

Phase I: Demonstrate the utility of artificial neural net methods by analyses using real data from the intended DoD application. This activity should also address probable hardware requirements and the practicality of transfer to the envisioned DoD application.

Phase II: Develop the envisioned application to the point where it can be employed and tested, on a trial basis, in a DoD or Defense manufacturing activity. In addition to developing and validating neural net methods for the envisioned application, plans for DoD or contractor testing and implementation should also be developed.

DARPA 92-198 TITLE: Definition and Development of Advanced Multi-Sensor Components for Inclusion in a Global Nuclear Proliferation Monitoring System

CATEGORY: Basic Research

OBJECTIVE: To define in technical detail a suite of sensors which would have application for inclusion in a worldwide system for detecting the production and testing of nuclear materials and weapons. Once a technical description of the sensor suite is defined, a prototype of such a multi-sensor monitor would be built and evaluated.

DESCRIPTION: This solicitation calls for an effort to design a multi-sensor platform that would collect, pre-process, and forward data and information pertinent to the detection and analysis of the production of nuclear materials used in nuclear weapons and the testing and use of nuclear weapons. Such a multi-sensor platform could be considered for inclusion in a global system for nuclear proliferation monitoring. For this effort, sensors chosen must be off-the-shelf or capable of being manufactured with existing technology. No limit is imposed on the number of sensors, but the proposed suite should be self-complementary.

Phase I: Design a prototype monitoring station. Estimated capabilities, including the sensitivity of the proposed sensors, must be included in the designs as well as the estimated costs to produce such multi-sensor monitors.

Phase II: Develop a prototype of the selected design, and evaluate the performance of this prototype.

DARPA 92-199 TITLE: Methods Using Three-Component Broadband Data to Locate Local and Regional Seismic Events

CATEGORY: Basic Research

OBJECTIVE: To develop procedures for processing and analyzing three-component broadband seismic data to determine the location of seismic events. Such procedures would then be incorporated into an automated signal processing package.

DESCRIPTION: Information on the arriving azimuth and phase identity of seismic signals is contained in the polarization and spectral content of such signals. Such information could be used to estimate the location and origin time of seismic events and applied in a routine manner through automated or interactive processing. This solicitation requests development of a package of signal processing algorithms which can be applied to signals at local or regional distances to provide single station locations of these events. This package will be evaluated against independent determinations of event location.

Phase I: Develop and describe a set of signal processing algorithms that provide the required information on the location of seismic events. Provide examples of the application of such algorithms to seismic data.

Phase II: Use the approved algorithms in a prototype signal processing package and apply it to data

collected from a U.S. seismic station used in the Group of Scientific Experts Technical Test II (GSETT-2). Compare these results with those provided by independent networks.

DARPA 92-200 TITLE: Automated Determination of Seismic Event Depth from Broadband Regional Seismic Data

CATEGORY: Exploratory Development

OBJECTIVE: To develop and test a method of automatically determining the depth of small (mb 2.5-4.0) shallow (less than 30 km depth) seismic events using broadband digital seismic data recorded at regional distances (200-1000 km)

DESCRIPTION: Methods are sought for automated and accurate determination of the depth of seismic events using broadband digital seismic data collected at regional distance ranges. Techniques to be used could include the differential traveltime methods of Duud, et al. (1988), the removal of scattered energy from the P-wave coda, and the identification of depth phases, or other techniques. The method must be capable of being incorporated into an automated seismic data processing scheme on the DARPA Intelligent Monitoring System (IMS).

Phase I: Provide a detailed description of the proposed concepts, together with examples of shallow earthquake and explosion data analyzed with the depth estimation technique and a plan for implementing the technique as part of the automated data processing package in the IMS.

Phase II: Test the method using data from the recent Group of Scientific Experts Technical Test and demonstrate the effectiveness of the method on the IMS for automatic processing of regional data.

DARPA 92-201 TITLE: Method for Correlating Mine Explosion Size with Seismic Magnitude

CATEGORY: Exploratory Development

OBJECTIVE: To develop and test a technique for determining the yield of mine explosions (open pit) and underground workings, ripple-fired and single shot, using data from broadband digital seismic stations at regional (200-1,500 km) distance ranges.

DESCRIPTION: DARPA has developed an Intelligent Monitoring System (IMS) that uses expert system techniques for the automated processing of data from a network of seismic arrays and three-component stations. A technique is sought for automatically and accurately determining the body-wave magnitude (mb) and yield of mine explosions using data from regional seismic networks. Methods that could be used include coda and body-wave magnitude measures, calibrated for the yield of mining explosions fired under various emplacement conditions and configurations.

Phase I: Provide a detailed description of the proposed concepts, together with examples of explosion data analyzed with the yield estimation technique, and a plan for implementing the technique as part of the automated data processing package in the IMS.

Phase II: Test the method with calibrated data from mining districts in stable and tectonically active geologic regions, and demonstrate that the method will perform automatically as part of the IMS analysis package.

DARPA 92-202 TITLE: Development of a Statistical Framework for Evaluating the Identification of Seismic Events

CATEGORY: Exploratory Development

OBJECTIVE: To develop and test a statistical framework for evaluating the identification of seismic events for nuclear proliferation monitoring.

DESCRIPTION: DARPA has developed an Intelligent Monitoring System (IMS) that uses expert system techniques for the automated processing of data for a network of seismic arrays and three-component stations and will use this system to test concepts for monitoring proliferation of underground nuclear testing. A multivariate

statistical package is sought that will incorporate realistic uncertainties in seismic signal measurements due to variability in earth structure and source mechanisms, while accounting for robust features that exist in the data and can be used for event discrimination. We seek a framework that will guide us in the development of a subsystem for the identification of small, shallow earthquakes and explosions, to be used in the IMS for monitoring of nuclear test proliferation.

Phase I: Provide a detailed description of the proposed statistical concepts, together with a plan for implementing the technique as part of the automated data processing package in the IMS.

Phase II: Implement the statistics in the DARPA IMS and demonstrate the effectiveness of the technique with a calibrated seismic event identification database.

DARPA 92-203 TITLE: Tools for Rapid Mapping and Analysis of Local Transportation Networks

CATEGORY: Exploratory Research

OBJECTIVE: To develop compositional modeling tools that will enable the rapid construction and analysis of transportation models. These tools will support rapid tradeoff analysis of different courses of action of a crisis action plan.

DESCRIPTION: With increasing U.S. reliance on rapid deployment military and humanitarian operations, crisis action planners confront the need to develop and analyze the local transportation network model that will be used to move troops and materiel from the port of debarkation (POD) to the theater assembly area (TAA). Developing this network model entails integrating intelligence data from various sources to create a detailed description of the transportation channels available in the region (roads, rail, etc.), capacities of those channels, any constraints affecting their availability, and facilities/constraints at the nodes on the network. These network models are used to develop and analyze alternative plans for in-theater transportation. Today, these network models are created manually, using maps and grease pencils. The opportunity exists to apply advanced technology to create object-oriented model representations of the network that link directly to in-theater transportation simulation models and to create tools that the planner can use to rapidly define, analyze, and modify network models that can be accessed quickly and modified to meet each new situation.

Phase I: Analyze one or more existing transportation models and define the improvements that could be obtained by advanced computer technology, including knowledge-based systems, object oriented programming, and decision theory. The offeror will prepare a functional specification of an object-oriented library and supporting model construction and analysis tool. The work will also include the definition of one or more hypothetical scenarios and quantifiable measures of evaluation (with supporting rationale).

Phase II: Construct a prototype of the object-oriented modeling tool and demonstrate its capabilities in a realistic transportation planning problem using one of the approved scenarios from Phase I.

DARPA 92-204 TITLE: Multi-Mode Transportation and Logistics Management

CATEGORY: Exploratory Research

OBJECTIVE: To define and create prototypes of tools based on advanced computer technology that will enable logistics managers and planners to create and support crisis action plans. These tools will provide a single representation of the transportation and logistics plan that can be used as input to models, simulations, and crisis action plans.

DESCRIPTION: Logistics managers are faced with the complex problem of ensuring the timely delivery of troops and materiel from myriad points of origin to destinations worldwide. Shipping a typical item may require transfer across several transportation modes (trucking, rail, air, shipping) and multiple carriers, both military and commercial. Each carrier has different rates and schedules. The logistics manager must create an itinerary for items to be shipped that meets the delivery requirements of the "customer" in the most cost-effective manner. Once the item is in transit, the manager must be able to identify its current location, in order to answer questions about status or arrival times, and to trace missing items. Today, these functions are manual, labor intensive, and incomplete; they yield results that are suboptimal. The opportunity exists to apply advance planning, scheduling, and simulation

technologies to create tools to assist the logistics manager in identifying transportation requirements, constructing transportation plans that meet those requirements, analyzing those plans for cost and feasibility, and monitoring the execution of plans once they are adopted.

Phase I: Identify shortfalls in present transportation and logistics planning capabilities and prepare a functional description and specification of new knowledge-based tools that will overcome these shortfalls. The description will contain one or more realistic military scenarios and quantifiable measures of improvement (with supporting rationale).

Phase II: Construct a prototype version of the tools specified in Phase I and demonstrate their performance in the scenario(s) approved from Phase I.

DARPA 92-205 TITLE: Fast Frame Buffer Research

CATEGORY: Exploratory Development

OBJECTIVE: To design a fast frame buffer that will eliminate the bottleneck in trying to transfer the large amounts of data that comprise an image from a source into the computer memory.

DESCRIPTION: In many image analysis applications, it is necessary to transfer digital data, representing large images, from one module to another, sometimes at TV frame rates. Although current computers may be fast enough to process large amounts of data, there is a major difficulty in getting such information from a source into fast memory. Current hardware/software techniques do not provide for the efficient transfer of such data.

Phase I: Develop the approach to be used in designing a fast frame buffer, and verify the approach through experiments carried out on a breadboard configuration.

Phase II: Redesign the breadboard based on the experiments and construct an advanced development model.

DARPA 92-206 TITLE: "Attention" in Active Vision

CATEGORY: Basic Research

OBJECTIVE: To design an "attention" system that selectively processes regions to obtain real-time performance with limited resources. Selective processing is necessary in vision systems that actively control camera parameters in response to the requirement of a task.

DESCRIPTION: Active vision systems have mechanisms that can actively control camera parameters such as position, orientation, focus, zoom, aperture, and vergence in response to the requirements of the task and external stimuli. Active vision encompasses "attention," selective sensing in space, resolution, and time, whether it is achieved by modifying physical camera parameters or the way data is processed after leaving the camera. Although the design of the "attention" system is potentially highly complex and will affect the design of visual processing at all levels, little is known about what this system should look like.

Phase I: Investigate and obtain solutions for issues such as: How should processing be enhanced or suppressed with respect to a region of attention, and which visual cues should be used to delimit the region of interest from the background?

Phase II: Implement the solutions obtained and incorporate them into an active vision system, such as an unmanned vehicle moving in a complex domain. Carry out experiments that demonstrate the effectiveness of the "attention" mechanisms.

DARPA 92-207 TITLE: Domain-Specific Software Architecture: Ada Reusable Software Assets

CATEGORY: Advanced Development

OBJECTIVE: To develop reusable software Ada parts, along with their software architecture, design, and requirements and rules for their use.

DESCRIPTION: Concepts are sought for innovative and novel ideas for developing reusable software Ada parts, along with their software architecture, design, and requirements and rules for their use. These parts and larger components composed from them may become parts in other larger systems written in Ada. Proposals must indicate how and why the proposed assets and tools will aid in building, re-engineering, understanding, improving the maintainability of the system, and supporting the concepts of domain architectures.

Phase I: Provide a detailed specification of the proposed software -- principles of operation, interfaces, software process, tool supports, etc. Proposals in the absence of an "architecture" and an assessment of the market usage are not acceptable.

Phase II: Demonstrate the tools/products. Address the issue of how these tools/products will interface with, coexist with, and be compatible with Software Technology for Adaptive, Reliable Systems (STARS) environments. This is an absolute requirement.

DARPA 92-208 TITLE: Low-Cost, Semi-Automated Electronic Data Interchange (EDI) for Small Businesses Supplying DoD

CATEGORY: Exploratory Development

OBJECTIVE: To develop a flexible capability to use standard electronic business transactions (purchase orders, etc.) effectively in enterprises that are not highly automated. To provide for growth as the enterprise automates its functions.

DESCRIPTION: As large Defense firms and the DoD implement EDI, small suppliers are finding they must accept electronic transactions from their large customers. The greatest benefit from EDI results from directly driving automated processes for ordering, submitting bids, shipping, billing, etc. The problem for many small businesses, however, is that these processes are not yet automated. Expensive EDI systems are being used by many small companies simply to print transactions for use along with transactions received by fax or mail, and EDI costs more rather than less. A cost-effective solution is needed as DoD transitions to EDI with its supplier base of over 70,000 small companies.

Phase I: Define a concept of operations, system architecture, and specifications for small business user systems and procedures. Make optimal use of planned DoD and commercial systems and standards for EDI. Evaluate the user interface concept for ease of use. Conduct a cost-effectiveness evaluation, and demonstrate analytically that the system concept can support the large scale of DoD EDI traffic and the wide range of levels of automation among small businesses.

Phase II: Construct a working prototype of the system and demonstrate its cost-effectiveness in real DoD spare parts procurements using EDI.

DARPA 92-209 TITLE: Simulation of Defense Manufacturing Processes at Multiple Levels of Abstraction

CATEGORY: Exploratory Development

OBJECTIVE: To develop an architecture for representation and simulation of manufacturing processes at multiple levels of abstraction.

DESCRIPTION: DoD needs a "virtual factory" simulation capability to facilitate concurrent engineering, transition to production, and production control. One key issue is the ability to simulate products, processes, and factory configuration at multiple levels of abstraction. A related issue, engendered by the need for fine-grained analysis of product and process designs, is the ability to scale distributed simulation models to manage tens of thousands of objects. A third issue is the ability for the simulation model to also function as the control system for the factory, with appropriate interfaces to manufacturing resource planning systems, cell controllers, and machine controllers. This project will address all three issues, with principal emphasis on the first.

Phase I: Develop a taxonomy of manufacturing processes, based on the literature in this field. Develop a scalable architecture for distributed simulations and visualizations that spans the portions of the taxonomy important to Defense manufacturing. Define a class structure to represent products, factory elements, and behaviors at multiple levels of abstraction within this architecture. Identify product and process modeling conventions and

representation forms that can be used to populate this structure. Develop a recommended implementation approach, with cost estimates and metrics for evaluating effectiveness.

Phase II: Demonstrate the modeling and representation approach, prototype the use of these representations in simulations at multiple levels of abstraction, and analytically assess issues of scalability for a specified subset of manufacturing operations and products.

DARPA 92-210 TITLE: Intelligent Conversion of Scanned Engineering Drawings to Product Data Models

CATEGORY: Exploratory Development

OBJECTIVE: To develop an architecture for a design associate system that will input information from an image understanding subsystem and, with human interaction, output product data models in standard form.

DESCRIPTION: DoD and Defense contractors have millions of engineering drawings stored as raster scanned images. Many of these drawings need to be converted into machine interpretable models for use in modern computer aided design (CAD), computer aided engineering (CAE), and computer aided manufacturing (CAM) systems. Existing raster-to-vector systems are limited in their ability to recognize features of engineering drawings, and to extract information about geometry, dimensions, tolerances, parts lists, materials, etc. The envisioned architecture would define the functions, information, and physical systems needed to achieve an order of magnitude improvement in the productivity of CAD system operators in converting scanned data to product models which adhere to national and international standards. The initial application will be limited to mechanical parts and assemblies.

Phase I: Identify an appropriate image understanding approach based on recent research results. Develop architectures (functional, information, and physical) and estimate development and production costs of the system. Identify technical risk areas. Compare the cost, cycle time, and effectiveness of the proposed system with current practices.

Phase II: Demonstrate the proposed approach with a prototype that accepts as input scanned images from DoD engineering data repositories. The prototype should focus on the risk areas identified in Phase I and should demonstrate productivity gains using the measures defined in Phase I.

DARPA 92-211 TITLE: Production Cost Estimators Based on the "Physics" of Manufacturing

CATEGORY: Exploratory Development

OBJECTIVE: To develop concurrent engineering tools that explicitly relate production costs to product and process design and to manufacturing system attributes. Couple cost estimation with "virtual factory" simulation to improve DoD capabilities to consider cost during the engineering and manufacturing development (EMD) phase.

DESCRIPTION: Current design-to-cost tools are based on parametric cost estimating relationships (CERs) derived through regression analysis, rather than explicit cause-and-effect models. This project will couple cost estimation with manufacturing process simulation at the detail design level. Cost estimates will be built up from a step-by-step process simulation (a "virtual accounting" approach). These estimates will be fed back into the iterative design process. Specifications for an intelligent design-to-cost advisor, with domain-specific knowledge of manufacturing processes, will also be developed.

Phase I: Develop a general architecture for constructive cost estimation coupled with simulation based on product, process, and factory configuration representations. Show conceptually how this architecture can be applied in a particular problem of interest to Defense manufacturing. Define the cost-related information required for constructive cost estimation, and identify the approach and data sources for obtaining this information. Define an approach for providing domain-specific advice on product and process changes to reduce cost.

Phase II: Demonstrate the cost estimation approach in a critical Defense manufacturing area. Prototype the "virtual accounting" system, couple it to an existing simulator, and show that the results accurately estimate actual production costs. Show that the approach can be scaled to cover the complete range of manufacturing processes and cost drivers. Develop specifications for an intelligent system to assist in analyzing "virtual accounting" results and recommending product and process improvements.

DARPA 92-212 TITLE: Automated Methods (Object Classes and Transactions) for Handling Intellectual Property Rights and Compensation in Electronic Commerce Networks

CATEGORY: Exploratory Development

OBJECTIVE: To develop an architecture to facilitate controlled access to information software and other intellectual property in electronic commerce networks.

DESCRIPTION: In the future Defense manufacturing environment, commerce will be transacted over networks linking prime contractors, suppliers, and customers. Control of access and appropriate accounting and compensation mechanisms are needed to safeguard the interests of the owners of intellectual property. This project will define a secure, agent-based architecture, and define object classes and transactions to manage the processes of requesting, authorizing, accessing, and providing compensation for intellectual property. The approach will be general (i.e., applicable to a broad range of problems), and scalable to electronic commerce networks with thousands of participants.

Phase I: Develop a conceptual architecture that addresses the functional, informational, and physical network aspects of the problem. Make appropriate use of emerging standards for object management, and define classes accordingly.

Phase II: Prototype the architecture in a Defense manufacturing application involving access to proprietary information on products and manufacturing processes.

DARPA 92-213 TITLE: Small, Light-Weight Auxiliary Power Unit (APU) for a Man-Portable Operator Control Unit (OCU) for the Unmanned Ground Vehicle (UGV)

CATEGORY: Exploratory Development

OBJECTIVE: To develop an APU with power supply to operate for extended periods of time.

DESCRIPTION: The military users for tactical unmanned ground vehicles have expressed a need for a man-portable OCU. This OCU will require a power supply to operate for extended periods of time. Any APU should be extremely small, light-weight, quiet, and fully compatible with military tactical operations. Heavy fuel operation is preferable.

Phase I: Design a state-of-the-art APU. Begin the research necessary to build the unit, and provide some experimental evidence that it is feasible.

Phase II: Continue the research, construct the prototype, and measure the effectiveness in a formal test.

DARPA 92-214 TITLE: Formal Methods Tools for Software Engineering Environments

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate an integration of formal methods tools into emerging open architecture software engineering environments (SEEs). Demonstrate means by which formal methods tools can be used to achieve high levels of assurance with respect to specific critical properties while retaining use of conventional tools and approaches in the SEE.

DESCRIPTION: Formal methods tools can provide a means to achieve high levels of assurance that systems or components conform to specific critical properties included in systems requirements. Critical properties can include safety, functionality, or other properties for which high levels of assurance may be required. Acceptable proposals must employ generally recognized specification formalisms and specify means for integration into generally recognized open architecture environment approaches. Proposals are encouraged to address issues related to the integration of diverse components into larger systems with high levels of assurance with respect to specific critical properties.

Phase I: Produce a detailed description of the approach to achieving trustworthiness. Also generate the

associated technical documentation, an engineering approach, an analysis of related research, and a viable plan for transitioning the technology into practice through direct commercialization, licensing to vendors, or other means.

Phase II: Develop a prototype capability suitable for experimental use, a demonstration of the means by which trustworthiness is achieved for selected critical properties, and a description of means for integration into SEE frameworks.

DARPA 92-215 TITLE: Technology for Trustworthy Compilers

CATEGORY: Exploratory Development

OBJECTIVE: To develop compiler technology that supports high levels of assurance of consistency in meaning between source code and object code. Results must be demonstrated to be potentially applicable in commercial quality compilers.

DESCRIPTION: Compiler technology is sought that can be used in applications where it is essential that high levels of assurance be provided that object code is semantically consistent with source code, whether it is achieved by means of audit trail generation by the compiler followed by an audit trail analysis, or by means of assurance provided for the compiler itself. Acceptable proposals must produce demonstration capabilities that can be potentially adopted for high performance compilers. Acceptable proposals must also address compilers for programming languages in general use for systems where there are high assurance requirements.

Phase I: Produce a detailed description of the approach to achieving trustworthiness. Also generate the documentation, an engineering approach, an analysis of related research, and a viable plan for transitioning the technology into practice.

Phase II: Develop a prototype capability suitable for experimental use and a demonstration of the means by which trustworthiness is achieved and could be achieved for related products.

DARPA 92-216 TITLE: Semi-Automated Speech Transcription System

CATEGORY: Exploratory Development

OBJECTIVE: To develop hardware, software, and algorithms for automating the transcription of natural speech.

DESCRIPTION: Researchers are making strong progress in developing large vocabulary continuous speech recognition algorithms, including some aimed at dictation by cooperative users. The purpose of the proposed effort would be to adapt those algorithms, to develop other needed techniques, and to handle situations where a person is conversing with other humans rather than with a machine. While fully automatic transcription of such speech is far beyond the current state of the art, it may be feasible to develop an interactive recognition system to help a person transcribe previously recorded fluent speech. A first generation system might be able to handle the speech of a single person (speaking extemporaneously), while a more advanced system might deal with multiple alternating speakers (as in a conference setting). In either event, the system would have to deal with open-ended vocabulary and unconstrained natural language, and it would not necessarily have prior examples of a speaker's speech.

Phase I: Design a proof-of-concept prototype system based upon state-of-the-art recognition algorithms. Begin the research necessary to build such a system and provide some experimental evidence that it is feasible.

Phase II: Continue the research, construct the prototype system, and measure its effectiveness in a formal test.

DARPA 92-217 TITLE: Integration of Information from Heterogenous Sources

CATEGORY: Basic Research

OBJECTIVE: To integrate data from remote computers with differing software, data representations, and abstraction levels for information analysis and display. New methods, and tools based on such methods, are needed.

DESCRIPTION: Advances in communication, such as are being brought about by the national networks and the High-Performance Computing and Communication (HPCC) initiative make much source information accessible to decision-makers, planners, and designers. When communication was via paper, the internal formats of stored data, their precision, and scale of their representations, as well as the extent of detail being kept at the various source sites, was likely to differ. Such differences are not only due to lack of standards, but also to differences in understanding, needs, relative importance, and access. To effectively combine such data for further processing, there exists a need for mappings which induce as little information loss as possible. Often, the matching prior to fusion cannot be carried out precisely, so that alternate choices must be represented, perhaps with associated certainty factors. When the source information is not equally up-to-date, further uncertainties are created. The methods and tools emerging from this research must present the decision-makers with the best possible fused information to lessen the risk of failures due to information loss, while avoiding information overload on the user.

Phase I: Develop novel methods and conduct simple isolated demonstrations of their effectiveness.

Phase II: Develop tools that implement promising methods, and test these tools on real-world information sources. The new DARPA initiative on knowledge-based technology for integration may provide testbeds.

DARPA 92-218 TITLE: Mapping Object-Structured Information Among Applications

CATEGORY: Basic Research

OBJECTIVE: To develop a means to convert information structured as objects for one task set into another object structure, optimizable for other tasks. Object-structured representations are typically optimized for a single task.

DESCRIPTION: Many modern programming and database systems support the representation of data in the form of complex objects, encompassing structured representation of multiple data elements and data element groupings. Programmed methods may be attached to the objects as well. These are typically defined to be optimal for the particular program or tasks which caused their initial definition. However, another program may need to share the same information within another task structure. A simple example exists in inventories, where the user may define objects based on the item configuration to be sold, say trucks composed of bodies, power units, transmissions, axles, and suspensions, and further down the hierarchy to bolts and nuts -- while the purchasing department categorizes the parts by supplier and the manufacturing unit creates classes based on production line, method, or material. Some or all of the information in these object representations must be jointly accessible. Information may be copied or represented in multi-object structures. In these mappings minimal information loss should occur, while synchronicity and redundancy of information must be managed.

Phase I: Develop novel methods with simple, isolated demonstrations of their effectiveness for shared-object management. Performance and scalability to real-world situations must be considered.

Phase II: Develop tools that implement promising methods, and test these tools on real-world information sources. The ongoing DARPA Persistent Object Base (POB) program may provide a foundation for test and demonstration.

DARPA 92-219 TITLE: Managing and Maintaining Knowledge Bases

CATEGORY: Basic Research

OBJECTIVE: To develop methods and tools for keeping large knowledge bases up-to-date. Both human interaction and automation by processing incoming factual and sensor-based information are relevant.

DESCRIPTION: The volume of knowledge needed in many applications of artificial intelligence is such that a single expert, or even a cohesive group of experts, cannot be expected to handle the maintenance of the knowledge base. Effectiveness demands that knowledge bases adapt themselves to real-world changes, in particular situational changes, new objects, object-types and object classifications, and to the bases for heuristics being used to process the knowledge. Growth of coverage of stored knowledge is also a concern and, with it, the non-monotonic changes of underlying assumptions. Maintenance of large knowledge bases by committee is likely to be costly and unresponsive to real-world situations. We are interested in methods that help the human experts effectively

contribute their changing knowledge to the knowledge bases, as well as in tools which monitor and abstract the real world and can understand the relationships to stored knowledge, tools which learn and update the knowledge bases, and in approaches that combine human and automated maintenance processes.

Phase I: Develop novel methods for the maintenance of stored knowledge, and demonstrate by simple isolation the effectiveness of these methods.

Phase II: Develop tools that implement promising methods, and test these tools on real-world knowledge bases. The ongoing DARPA planning program may provide a foundation for test and demonstration.

DARPA 92-220 TITLE: Abstracting Information from Spatial Files and Databases

CATEGORY: Basic Research

OBJECTIVE: To develop methods for effective transformation and abstraction of spatial information. Geographic and other spatial base files contain important information for many tasks, but must be processed to be effective for the particular task.

DESCRIPTION: Spatial data are becoming an important source of information for many applications. Examples are maps of terrain, political boundaries, and features created and changed by human intervention. Spatial information is needed to represent manufactured objects and activities during the design, manufacturing, assembly, maintenance, and recycling processes. A number of interesting representations are now in use or proposed, often particularized to the application defining them. In order to track information over long lifetimes, for a variety of objectives, we need criteria and methods for effective capture and update of base information, and abstraction mechanisms for particular processing and display tasks, with estimators on the information loss sustained when moving among abstractions.

Phase I: Develop effective and robust methods with simple, isolated demonstrations for storage, abstraction, and maintenance of spatial data. Criteria of effectiveness, performance, and scalability to real-world situations must be considered.

Phase II: Develop tools that implement promising methods, and test these tools on real-world spatial bases. DARPA programs in manufacturing technology and image processing may provide material for test and demonstration.

DARPA 92-221 TITLE: Conceptual Vehicles for Operation in the Surf Zone

CATEGORY: Exploratory Development

OBJECTIVE: To investigate innovative vehicle/sensor systems for mine search in the surf zone (i.e., shallow water from 10 to 40 feet).

DESCRIPTION: There is a need for an autonomous or remotely-controlled underwater vehicle that can covertly search for underwater mines in the surf zone. Such a vehicle would be required to execute a systematic mine search in the presence of wave action as well as in calm seas. There is no specific requirement relative to the sea state in which the vehicle must operate; however, it is desired that the vehicle operate in as high a sea state as possible.

Phase I: Develop a high-level design of a vehicle and sensor suite that could perform this mission, and estimate the maximum sea state in which the vehicle could operate.

Phase II: Develop a detailed design of a vehicle and a plan for the fabrication and test of the system.

DARPA 92-222 TITLE: Lightweight, Intelligent Speed Reducers and Controllers

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate concepts for lightweight, low-cost, modular intelligent controllers, and speed reducers to facilitate performance and cost gains for automated machinery systems.

DESCRIPTION: There is a need to develop new automation applications or to upgrade existing machinery based

systems with lightweight, intelligent controllers and speed reducers. In the future, machinery will require more fully distributed intelligent control and close proximity of sensing, signal processing, data fusion, state reasoning, and state control devices. Systems that are both modular and extendable both in hardware and software and that can utilize alternative control strategies are required. This is a new field that requires interdisciplinary expertise.

Phase I: Develop a conceptual design for lightweight, low-cost, intelligent controllers and speed reducers. Demonstrate subscale concept feasibility of the selected design. A trade-off analysis with appropriate metrics is required.

Phase II: Design and demonstrate a full-scale prototype of a representative low-cost, intelligent controller or speed reducer. Conduct performance and cost sensitivity analysis to demonstrate viability of concept.

DARPA 92-223 TITLE: Full-Scale Submarine Control Surface Lift, Drag, and Torque Measuring Devices

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate full-scale devices for measuring submarine control surface lift, drag, and torque during at-sea operation and testing.

DESCRIPTION: DARPA is interested in developing and demonstrating full-scale instrumentation for measuring control surface forces (lift, drag, bending moment) and torques and moments. DARPA has identified the need to develop instrumentation for full-scale submarines in order to use the data for computational fluid dynamics (CFD) and maneuvering prediction code validation. Currently, no method exists to accurately measure the large-scale forces, moments, and torques on submarine control surfaces. Current systems are not scalable to full scale. A full-scale measurement system would provide, for the first time, the critical data needed to support DARPA's efforts in the development of CFD codes for computation of the highly complex, incompressible, and high Reynolds number submarine flows. This technology also has applications in acquiring measurements for demonstrations of advanced control surface technology, such as Flap Assisted Control Surfaces (FACS), Automated Control, or Remote Silent Actuation Systems.

Phase I: Perform preliminary design of measurement system.

Phase II: Conduct large-scale demonstration of measurement system.

DARPA 92-224 TITLE: Neural Network Technology in Composite Fabrication

CATEGORY: Advanced Development

OBJECTIVE: To improve fabrication of thick polymer matrix composites by use of neural network technology.

DESCRIPTION: DARPA is developing advanced techniques for cost-effective, high-rate fabrication of high-quality, thick-composite materials. This program is pushing the state of the art in manufacturing, quality control, and non-destructive evaluation. Neural networks would meet the requirement of advanced monitoring and control systems. The use of neural networks in fabrication would enable the fabrication system to produce quality, thick-composite products through an optimal process that can be learned, real-time, by the system. Neural networks would effectively reduce the amount of time required to develop optimum fabrication processes.

Phase I: Develop system architecture and algorithms required for monitor, control, and evaluation of composite material fabrication.

Phase II: Demonstrate neural network capability in subscale composite structure.

DARPA 92-225 TITLE: What is the Physics of High-Voltage Breakdown in Polymer Films?

CATEGORY: Basic Research

OBJECTIVE: To identify the physics responsible for the high-voltage breakdown of polymer films, especially polyureas and polyurethanes.

DESCRIPTION: It has been found that certain polyurethanes and polyureas respond to the imposition of electrical

fields with a change in volume. However, the fundamental physics and physical chemistry is not understood. There have been papers in the chemical literature reporting closely similar volume changes in both sign (a shrinkage) and in magnitude (10%) caused by changes in the molecular weight of the "soft" segments, and it is conjectured that it is a phase change mechanism induced by the electrical fields that gives rise to what has been observed. There have also been papers concerned with optical phenomena that report on changes induced by electrical fields, but there appears to be no fundamental work dealing with electromechanical phenomena. The need for physical understanding is motivated by a desire to improve a number of material properties. For example, the voltage fields at which the electroacoustic effects are maximized are around 1000 volts per mil, which is very large. This is a new field that requires interdisciplinary expertise (in addition to the core chemistry expertise of several disciplines). These include: the mechanical engineering notions of moduli and working fatigue; physics of surface interface phenomena; acoustics and radiation coupling; and, sophisticated electronics for the instrumentation needed to measure the properties of interest, which are an absolute necessity.

Phase I: Develop experiments, models, and insights into the electroacoustic behaviors of polymer films.

Phase II: Provide advanced exploration of critical properties identified in Phase I. This effort may result in techniques to identify optimum polymers for low-frequency acoustic transmitters.

DARPA 92-226 TITLE: Investigate the Feasibility of Autonomous Decoys to Decrease the Probability and Success of Submarine Attacks upon Other Ships and Submarines

CATEGORY: Exploratory Development

OBJECTIVE: To explore the feasibility of autonomous decoys to decrease the probability and success of submarine attacks upon ships and submarines.

DESCRIPTION: The approach-and-attack problem for a submarine can be greatly complicated if it must verify that it is not attacking a cheap decoy rather than a high-value target. Small, cheap, autonomous, long endurance decoy vessels could be repeatedly sent through the ocean areas where there is a submarine threat. These unmanned vehicles would reproduce the sound and possibly radar return of much larger vessels. They would not only draw fire away from real ships, but their mere existence would require that enemy submarines always visually verify that what they are attacking are real ships. This approach has a high leverage against any submarine force, but will be of even greater value against non-nuclear subs encountered in regional conflicts which have only a limited range or ability to reposition for a reattack. Other innovative concepts of antisubmarine warfare (ASW) by confusion, especially using unmanned vehicles, will be considered under this solicitation.

Phase I: Investigate the feasibility of such autonomous ASW decoy vehicles including endurance, speed, control, fidelity of decoy signatures, cost, and operational utility estimates.

Phase II: Design and possibly develop and test the critical systems or concepts identified in Phase I.