DEFENSE ADVACED RESEARCH PROJECTS AGENCY

The responsibility for carrying out DARPA's SBIR Program rest with the office of the Controller. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DAROA at the following address:

DARPA/COMPT/SBIR
Attention: Dr. Bud Durand
1400 Wilson Boulevard
Arlington, Virginia 22209-2308
(703) 527-0666

The proposals will be processed in the office of the Comptroller and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 83 technical topics, numbered SB91-001 through SB91-083, to which small business may respond in this first fiscal year (FY) 1991 solicitation (91.1). Please note that these are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included 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 us to pursue as may 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 has been lowered to $250,000.

DARPA selects proposals for funding based upon technical merit and 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 prepares 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.

SB91-001 TITLE: Innovative Detection and Targeting Sensors for Camouflaged, Low Radar Cross Section Ground Targets

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate innovative sensors for the detection and targeting of reduced-signature ground vehicles.

DESCRIPTION: DARPA is investigating advanced technologies for detecting and targeting next generation ground vehicles which seek to achieve survivability by hiding in dense cover and employing deception and denial techniques. Current technology used to reduce the detectability of ground vehicles such techniques as the use of camouflage netting, both visible/infrared (IR), and radar scattering. Next generation ground vehicles can be expected to employ even more advanced techniques to further reduce their detectable signature. DARPA is interested in innovative sensor and processing technologies to detect, classify and target these next generation ground vehicles. Possible approaches could include use of unusual regions of the electromagnetic spectrum, unique signature phenomenology differentiating manmade and natural objects, innovative combinations of sensors, and innovative signal processing techniques. Strong emphasis will be placed on truly innovative concepts that offer the potential for significant improvement in capability, even if there is technological risk. Proposals must include a discussion of how the significant improvement in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally useful.

Phase I: Provide detailed analysis of the proposed detection sensor technique based on physical principles a s well as an analytical assessment of available experimental data. Include a prediction of the increase in operational capability as a result of the technique (e.g. improved detection range, increased probability of detection, reduction in false alarm rates, etc.)

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

SB91-002 TITLE: Innovative Applications of Acoustic Charge Transport Signal Microprocessor Technology

CATEGORY: Advanced Development

OBJECTIVE: The objective of this project is to demonstrate significant enhancements in a military electronics system application through the use of an acoustic charge transport (ACT)-based signal microprocessor.

DESCRIPTION: ACT technology has evolved in recent years from basic research activity, through the demonstration of a variety of specific devices, to the currently available “signal microprocessor”. The “signal microprocessor” is a high capability, digitally programmable, integrated circuit which can process analog signals by mathematical computation, thereby providing the same type of functionality for analog signals as the traditional microprocessor does for digital data. Such a device combines analog processing speeds and simplicity with the programmable versatility traditionally attributed only to digital processing techniques. Indeed, the signal microprocessor can be implemented all-digitally as an integrated circuit surrounded by convertors, but even the currently available ACT-based microprocessor is 1,000times faster than any available digital version and can operate on signals in the video, IF, and RF frequencies while digital versions operate only at audio frequencies.

Functionally, the ACT-based microprocessor can be represented as a digitally programmable transversal filter. A standardized unit provides 128 taps, currently available 6-bit tap weight accuracy, and 150 MHz bandwidth. The unit requires only external DC power and a standard PC printer interface for control. The hardware is supported by a user friendly software package which automatically and dynamically controls tap weighs in response to user

objectives, specified in a wide variety of ways. Units can be stacked for greater accuracy or cascaded for more taps/delay lengths. It is clear that such a device presents a powerful capability that has application in a variety of military electronic systems. It is the intent of this topic to identify and demonstrate such applications.

Phase I: Identify a promising application of an ACT-based signal microprocessor which would enhance an existing military electronic system concept or allow for the development of a new capability. While the concept may be demonstrated in this design study, the use of laboratory experiments for demonstrating feasibility demonstration model of the system concept and demonstrate its performance.

Phase II: Build a feasibility demonstration model of the system concept and demonstrate its performance.

SB91-003 TITLE: Low-Cost, Distributed Simulation of Logistics for the Interoperability of Defense System Simulations

CATEGORY: Exploratory Development

OBJECTIVE: To explore and implement concepts for realistically portraying the effects of logistics in the distributed simulation of combined arms warfare (i.e. personnel replacement, resupply, and maintenance.)

DESCRIPTION: The modeling of logistics in the distributed simulation id a combined arms battle is generally of a lower fidelity than the modeling of the combat arms. It is recognized that logistics constrains affect the tempo if the battle; however, as it is currently implemented, the logistic model is incomplete. It only approximates the delays introduced by resupply, replacement and maintenance, and it does not realistically task combat service support personnel in their wartime duties. As a result, the training received by the support staff is degraded, and credibility of the simulation suffers.

Phase I: Prepare concepts for the realistic modeling of logistics, and concepts for how that model might be implemented at a workstation(s)as part of a larger network of simulators.

Phase II: Develop, test, and validate selected concepts in a stand alone local area network for the training of support staff, and as part of an existing network of simulators for simulation of a combined arms battle.

SB91-004 TITLE: High Sensitivity magnetic Sensors for Remote Detection of Ground Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system of sensor capable of detecting and localizing objects of military interest using disposable distributed sensors.

DESCRIPTION: A continuous or highly distributed system of low cost magnetic sensors is desired which is capable of detecting the approach of ground vehicles, such as trucks, or small objects, such as rifles, from distances of 50 or more meters. These sensors may be ground based or strung over trees. These devices should be capable of discriminating against magnetic noise/interference, and should be capable of localizing and, if possible, establishing a vector to the target. Transmission of sensor data to a central node need not be addressed, however, systems with inherent data transmission capabilities will be considered as advantageous.

Phase I: Define magnetic senor system design/optimization. Calculate system effectiveness, accuracy, noise immunity, and development cost. Filed demonstrations of critical parameters with objects of interest are desirable.

Phase II: Test and demonstrate a complete system in both laboratory and filed environments. Develop production cost estimates for the proposed system.

SB91-005 TITLE: Flexible, deformable Surfaces Formed from Arrays of Sub-Millimeter Sized, Linear Electromechanical Actuators.

CATEGORY: Exploratory Development

OBJECTIVE: To develop a two-dimensional array of interconnected, submillimeter, electromechanical devices and the processing system to precisely control exterior surface shape of a section of a scaled aircraft wing.

DESCRIPTION: Micro-machines, micro-motors, and micro-actuators have been developed which are smaller than 1.0 mm^3 in volume, extremely light, and exhibit extremely rapid response times. This project seeks to explore the feasibility of using this technology to build light, deformable aircraft surfaces which 1) enable low drag flight for various flight conditions and velocities, and 2) perform the aircraft control functions normally accomplish by wing flaps.

Phase I: Develop an innovative concept for appropriate individual electromechanical devices, a concept for connecting devices into an array, and a concept for a processing/control system, investigate resulting system concept (s) to determine advantages and disadvantages of concept for the intended application.

Phase II: Construct and test a proof-of-principle demonstrator.

SB91-006 TITLE: Survivability Enhancement Technology for the Light Infantry Foot Soldier

CATEGORY: Exploratory Development

OBJECTIVE: To provide significant improvements in the survivability of the individual foot soldier against opposing forces, particularly in low intensity situations with difficult terrain such a jungles or mountains.

DESCRIPTION: Individual soldier survivability may be enhances by better protection, reduced visual signature, greater mobility, greater firepower, improved communications, improved ability to detect and aim at enemy soldiers, an ability to rapidly and accurately cue heavier arms, and many other methods. Proposed concepts should be capable of providing a significant payoff and should impose minimal burden on the soldier.

Phase I: define survivability system design/optimization. Provide a complete assessment of the technical performance and the required technical development, as well as an assessment of the operational payoff and cost versus other known approaches. It is desired that key technologies or components be demonstrated.

Phase II: test and demonstrate a complete system in the laboratory and the field. Develop production cost estimates for the proposed system.

SB91-007 TITLE: Novel Configurations of Electromagnetic Linear Accelerators with High Electrical Efficiency

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for electromagnetic launcher components.

DESCRIPTION: Concepts are sought for novel configurations of electromagnetic accelerators for gun and launch application. The emphasis should be on high electrical efficiency and the absence of high current arcs, current collection brushes and mechanical commutation.

Phase I: Provide a detail definition of the proposed concepts followed by an optimized design and performance analysis of proof-of- principle hardware. Some subcomponent development may be appropriate.

Phase II: Construct and test the proposed proof-of proof hardware.

SB91-008 TITLE: High Power, High Energy density Electrical Storage Devices to Provide Pulse-Power for Electric Weapons.

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for high power, high energy density electrical storage devices to provide pulse-power for electric weapons.

DESCRIPTION: Concepts are sought for novel configurations for storage and pulse forming power supplies. The emphasis should be on device goals: energy densities in excess of 15 kJ/kg and power densities of 100 kw/kg.

Phase I: Provide a detailed definition of the proposed concepts followed by an optimized design and performance analysis of proof-of proof principle hardware. Some subcomponent development may be appropriate.

Phase II: Construct and test the proposed demonstration hardware.

SB91-009 TITLE: Miniaturized, Integrated Guidance and Control Unit for Projectiles

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches to guidance and control of tactile projectiles.

DESCRIPTION: Novel guidance and control concepts are sought to improve the accuracy of extended range, direct- and indirect fired projectiles. Concepts of interest would include novel aeroballistics control devices and inertial or command guidance components. The emphasis should be on simple, miniature, low cost concepts which would be compatible with high acceleration launch from hypervelocity guns.

Phase I: provided followed by an optimized design and performance analysis of proof- of principle hardware. Some subcomponent development may be appropriate.

Phase II Construct and test proof-of- principle hardware.

SB91-010 TITLE: Innovative and Novel Means of Attacking and Disabling Tactical Armored Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To explore new and innovative means of defeating armored vehicles other than massive disruption of armor.

DESCRIPTION: Concepts are sought for innovative and novel means of attacking target armored vehicles by reducing or eliminating effectiveness of vehicle power, mobility, armor, and crew capability, and/or rendering them vulnerable to further attack. Technologies which can disrupt the tempo of operations, commend and control, and target acquisitions, degrade the ability of follow-on forces, or interrupt logistics, can also be considered.

Technologies which would support anti-drug or anti-terrorist operations are also of interest. Concepts for penetration of heavy armor are not of interest in this request.

Phase I: provide a detail definition of the proposed concepts followed by an optimized design and performance analysis of proof-of-principle hardware. Some subcomponent development may be appropriated.

Phase II: Construct and test the proposed demonstration hardware.

SB91-011 TITLE: Low Cost Semi-Active Guidance Systems for 40 mm Rifle Grenades

CATEGORY: Advanced Development

OBJECTIVE: To develop a system allowing an individual foot soldier to accurately aim 40mmlow velocity grenades in order to shoot into small openings in bunkers or entrenched areas.

DESCRIPTION: A rifle-mounted designator or other guidance device is desired to provide greatly enhanced accuracy (e.g., +/-6 inches or better) to a round aimed within 1 to 2 degrees of target. The round should be compatible with the current 40mm launcher and should provide a similar lethal effect, but should use the guidance device signal to achieve significantly improved accuracy. Cost of the round will be a significant factor.

Phase I: provide detail system design. Thoroughly analyze technical performance and develop production cost. It is desired that key components be demonstrated if possible.

Phase II: fabricate and demonstrate all key subsystems. If possible, a complete system (without fuze and explosive) shall be demonstrated. Production cost estimates shall be refined.

SB91-012 TITLE: Advanced Diagnostics for Characterization of Projectile Aerodynamic Orientation

CATEGORY: Advanced Development

OBJECTIVE: To develop and demonstrate a diagnostic system able to characterize the instantaneous location and orientation of a kinetic energy projectile with a resolution of one millimeter or less at an instant in time.

DESCRIPTION: Pitch and yaw at the moment launch and impact, as well as in flight, are important parameters when characterizing the ballistic performance of a kinetic energy projectile. The orientation becomes even more crucial as projectiles get longer and thinner. Even if the pitch and yaw cannot be precisely controlled, one may characterize the performance much more accurately if the orientation is known. Presently, the best way to get information on projectile orientation is through the use of orthogonal X-ray stations. This procedure can be laborious, clumsy and slow. Additionally, most test facilities are limited in the number of X-rays they can use. A system is needed that can characterize the flight of a projectile over an extended range without influencing that flight. Data should be available with a quick turn around and an interface should be available to record the data electronically.

Phase I: Provide an innovative, detailed design which can provide a proof-of- concept demonstration of each candidate system.

Phase II: Develop and fabricate a “breadboard” system which could prove the concept with actual hardware.

SB91-013 TITLE: Advanced Materials for Anti-Armor Applications

CATEGORY: Advanced Development

OBJECTIVE: To utilize innovative fabrication techniques to produce aeroshells, sabots or other projectile support structures from lightweight, high modules composite materials.

DESCRIPTION: Lightweight, high modulus, composite materials (such as graphite or boron fibers with a matrix of epoxy resin) should be ideal for use as structural elements (i.e. aeroshells or sabots) in kinetic energy projectiles. The structures must be capable of accepting high dynamic loads (80 to 100 kilogees) without failure and transferring those loads to kinetic energy projectiles. Any mass savings can be directly converted to higher velocity or more mass in the projectile. However, the lack of consistency in properties and fabrication techniques has limited the application of these materials. Innovative concepts for utilizing these type of materials, along with the proof of

the fabrication methods, would help to extend the use of composites and improve the performance of kinetic energy projectiles.

Phase I: Develop fabrication techniques for selected composite materials to meet desired performance goals.

Phase II: Demonstrate fabrication technique and perform static and dynamic test of fabricated composite structures.

SB91-014 TITLE: Arms Control Registration without Physical Tags

CATEGORY: Basic Research

OBJECTIVE: Develop methods for registration, inventory, and tracking of arms control treaty-related items without use of attached physical tags.

DESCRIPTION: partners to a treaty could periodically send each other non-invertible encrypted (hashed) list of the locations and individual identities of all treaty-limited items (TLI). At some later time, hours or months, all or portions of these list could be made clear, either routinely on in response to a challenge; and open hashing algorithm could be used to authenticate the cleared list. A challenge could, for example, ask for a demonstration of the hashing of the entry to show the TLI closest to a specific location at a specific time some months past. To the degree that the movement of the TLI were random, no information about current locations would be revealed by this procedure. In conjunction with other inspection techniques, such a procedure could possible enable at least probabilistic tracking of TLI from factory to destruction.

Phase I: Conduct an operations research analysis of the registration and tracking of TLI by used of hashed lists. Discuss the types of equipment which could be controlled, degrees of control, cooperative use with other inspection techniques, methods for creation and transmission of the lists, frequency with which the list are updated, optimum strategy for both sides to the treaty, possible cooperative use of physical tags, security aspects of the problem assuming the existence of non-invertible encryption functions, how evasive substitutions of warehouse for field TLI could be controlled, other possible evasion topics, and other topics which are considered to be relevant.

SB91-015 TITLE: Three-Component, 3 Dimensional, graphical seismic Event Location

CATEGORY: Engineering Development

OBJECTIVE: Design and develop interactive 3-Dimensional graphical techniques for display of 3-component seismic data to enhance determination of the station event azimuth emergence angle.

DESCRIPTION: there is extensive literature on the use of automatic, non-linear techniques to determine the back azimuth and emergence angle seismic signals recorded at a single 3-component station at teleseismic and regional distances. Routine analyst practice from earliest days of seismology has determined back azimuth from the inverse tangent function applied to the ratio of first motion amplitudes on horizontal components. This project should provide the analyst with a computer interface to enable him to fluidly use as much of the signal as possible, both in time and frequency and to force solutions using mathematical solutions only as guides.

Phase I: Design a prototype graphical interactive processor for 3-component seismic data at teleseismic and regional distances. Demonstrate the prototype on actual data. The prototype is to use X-Windows and other software standards of the Nuclear Monitoring Research Development (NMRD) systems to ensure final compatibility with those systems.

Phase II: Train a seismic analyst to use the system developed in Phase I, and have him or her exercise it on extensive data from Eurasian events in bulletins determined by the NMRD systems. Improve the system, both in capability, friendliness, and speed in response to comments from the analyst. Develop new processors and analyst procedures to achieve better agreement between true and calculated azimuths. Compare to automatically determined azimuths.

SB91-016 TITLE: Coupling in Jointed Media

CATEGORY: Basic Research

OBJECTIVE: Perform laboratory experiments to directly investigate the effect of rock joints on the seismic coupling of explosions.

DESCRIPTION: The role that rock joints play in the coupling of seismic waves from nuclear explosions is a subject of controversy. It is generally agreed that since rocks are weakened by joints, the coupling must be increased. However, there are no theories which quantify this increase without an unacceptable number of free parameters. The object of this study is to perform laboratory experiments to provide basic data for analysis, and perhaps to give direct experimental insight into the size of the effect of joints.

Phase I: Design a set of laboratory experiment to determinate the relative coupling of intact and jointed rock (perhaps simulated by cutting up the intact rock into small cubes and re-assembling) in dry and saturated conditions under confining stresses typical of burial at depths of 300-600 meters, if possible obtain sine initial experimental results. Discuss methods of analysis of the data and the extrapolation to nuclear scales.

Phase II: carry out the complete set of experiments design in Phase I. Discuss possible field experiments with conventional explosives and perform analyses to extrapolate the results to nuclear scales.

SB91-017 TITLE: Seismic Discriminants for Eurasia

CATEGORY: Basic Research

OBJECTIVE: Develop and test techniques to discriminate between quarry blast and earthquakes using events in regional seismic bulletins produced at the Center for Seismic Studies.

DESCRIPTION: monitoring of low threshold nuclear test ban treaties will depend on our ability to identify earthquakes and explosions down to magnitude mb of about 2.5 For the Soviet Union, a large database consisting of analyzed regional seismic recordings of such events is now being accumulated at the DARPA Center for seismic Studies, and the DARPA research program has produced a number of techniques that show some promise as discriminants for such events. DARPA has also sponsored the development of an Intelligent Monitoring System (IMS) for the automated analysis of seismic data, and this system is currently being expanded to include a framework for event identification. This project is aimed at testing known discriminants using events in the Center database, and developing and testing new discriminants on the same data. Results of the investigation will be used to design new discrimination modules for the IMS.

Phase I: review regional discrimination techniques, including depth, in the literature. Develop a systematic discrimination procedure which allows for the existence of unified events in the case of discriminate overlap and in the case of insufficient data or signal to noise ratio. Discus quality control parameters for the discriminants. Discuss step by step, voting, and multi-dimensional statistical decision procedures. Discuss performance of the discriminants in the presence of evasion scenarios. Define the magnitude and geographical range to be considered. Gather a prototype representative but small database and exercise the discriminates on that database.

Phase II: Exercise the discrimination procedure developed in Phase I on as much as possible of the analyzed data available at the CSS which fits the magnitude and geographical range defined in Phase I.

SB91-018 TITLE: Automatic Image Scanning for Quarries, Mining, Drilling and Craters.

CATEGORY: Engineering Development

OBJECTIVE: develop means for automatic of overhead digital images for quarry, mining, and drilling operations; and for explosion generated craters.

DESCRIPTION: many seismically detected explosions are due to mineral development activities. The determined locations of these events are often inaccurate, with typical errors of 20 kilometers. Thus, if overhead imagery were available, it would be necessary to scan images of approximately 1600 square kilometers to find possible sources of the seismic activity to examine further. This is a substantial analytic workload to accomplish without an analyst aid or tool. It is not necessary that a totally automatic method be developed; simply an approach. For example, a scraped-earth detector and zoom capability, could provide perhaps a ten-fold or more improvement in analyst coverage speed without substantial loss detection capability.

Phase I: Design procedures and systems to enhance detection of mineral development activities in overhead images by factor of 10 or more over simple scanning. Perform s prototype demonstration using an overhead image.

Phase II: Develop a prototype analysis system, analyze a large data-base of overhead images and detect mineral development operations. Compare speed of analysis to routine analysis. Compare to independent list, such as records of regulatory agencies, to discover and characterize missed detections. Determine false alarms by additional investigation of questionable detections.

SB91-019 TITLE: Advanced Microwave and Millimeter Wave Devices and Circuits.

CATEGORY: Advanced Development

OBJECTIVE: to advance the development and fabrication of microwave and millimeter wave device and monolithic format circuits that will provide performance levels and satisfy system requirements that are not being adequately met.

DESCRIPTION: Gallium arsenide metal-semiconductor field transistors (GaAs MESFETs) are being successfully used in a wide range of microwave applications and many millimeter wave applications. However, these devices and the circuits using them have performance limitations in terms of noise, power output and efficiency, particularly at frequencies above 50 Ghz. This project is directed toward the development of devices and monolithic format circuits from other material combinations (e.g. heterostructures, indium phosphide) that provide performance improvements compared to the present devices and circuits. Particular emphasis should be placed on meeting military system requirements that cannot adequately be met with existing structures.

Phase I: select one or more devices and/or monolithic format circuits that offer the possibility of performance improvements at microwave and millimeter wave frequencies beyond the present state-of-the-art. Develop a plan for the fabrication of the device and/or circuit structures that will result in production at the lowest possible cost.

Phase II: develop final design and fabricate prototype samples of the device and circuit structures selected for demonstration. Measure and provide report on the microwave or millimeter wave frequency performance characteristics.

SB91-020 TITLE: Innovative Packaging Techniques and Package Models

CATEGORY: Advanced development

OBJECTIVE: To advance the development and fabrication of packaging structures for digital and analog (microwave and millimeter wave) circuits that result in improved performance characteristics, packing and lower cost.

DESCRIPTION: Advanced multi-chip packaging structures and packaging boards containing a number of interconnected chips offer the promise of providing improved overall system performance at lower cost. Packaging structures for millimeter wave frequency analog devices are at en embryonic stage of development. New materials

and techniques should allow improved performance characteristics at a lower unit cost than is presently possible with each individually packaged in a conventional structure.

Phase I: select one or more packaging approaches for either digital circuits, millimeter wave frequency circuits or both. Develop one or more approaches for packaging these circuits in a manner that leads to improved overall performance at the lowest possible cost. Describe performance/cost tradeoffs for each approach studied.

Phase II: develop final designs and fabricate prototype samples of the package structures selected for demonstration. Measure and report on their performance characteristics. Develop a plan for producing these packages in large quantities including a description of necessary equipment and facilities.

SB91-021 TITLE: Computer Aided Design and Process Models for Microwave and Millimeter Wave Devices and Circuits

CATEGORY: Advanced Development

OBJECTIVE: To provide models for microwave and millimeter wave frequency solid-state and monolithic format circuits that accurately predict actual device and circuit performance over the widest possible frequency range. Emphasis should be placed upon the development of models that predict device/circuit performance from processing parameters and that operate on commercially available computer aided design software packages and workstations.

DESCRIPTION: At the present time, reasonably accurate models are available fro microwave solid-state devices and circuits that operate in a linear mode within the frequency range from 1 to 20 GHz. Additional work is needed to improve the accuracy of models for operation of devices and circuits in the 20 to 100 GHz range and for operation of active devices in a non-linear (high power) mode. Devices of particular interest are metalsemiconductor field effect transistors (MESFETs), high electron mobility transistors (HEMTs) and heterojunction bipolar transistors (HBTs) fabricated from III-V compound semiconductor materials. Circuits of particular interest are in a monolithic format fabricated from gallium arsenide. Most desirable are models which can be used to tie processing parameters to circuit design parameters.

Phase I: Select one or more devices and/or circuit configurations and develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements. Consideration should be given to how proposed models will extent computer aided design capabilities beyond those afforded by use of currently existing models, and to compatibility of models with existing commercially supported software package and workstations.

Phase II: Complete model development and write appropriate software description that can be used in conjunction with commercially supported software and workstations.

SB91-022 TITLE: Computer Analysis of new Microwave Devices and/or Monolithic Circuit Techniques

CATEGORY: Advanced Development

OBJECTIVE: To provide computer aided design methods to accurately analyze the predicted performance of new analog device and/or monolithic format circuit structures intended for operation in the 1 to 100 GHz frequency range.

DESCRIPTION: A number of recent device structures have been proposed which may result in superior transmitter and/or receiver performance at microwave and millimeter wave frequencies. In some cases, the basic device structure is not new but the material structure proposed for device fabrication is; in other cases completely new device structures are under consideration. Similarly, new circuit designs are under consideration that result in performance advantages such as broader-band operation, higher efficiency operation or higher power outputs. This project will result in the development of computer aided design techniques and models that can be used to analyze

the performance and advantages of new devices and monolithic format circuits in microwave and millimeter wave systems.

Phase I: Select one or more promising microwave and/or millimeter wave device and/or monolithic format circuit structures for model development. Provide a proposed model with clear indication of accuracy and needed improvements.

Phase II: Complete modeling and computer aided design software with emphasis upon accuracy and compatibility with existing commercially available computer aided design software and workstations.

SB91-023 TITLE: Receiver Protection Technology for Microwave/Millimeter Wave Monolithic Integrated Circuits

CATEGORY: Advanced Development

OBJECTIVE: To develop novel, low cost, practical methods for protecting microwave/millimeter wave monolithic integrated circuits (MIMICs) from damage caused by pulsed electromagnetic radiation (EMP) from friendly or hostile sources

DESCRIPTION: MIMIC circuits afford excellent performance characteristics at low cost and with high reliability for numerous DoD applications. For some of these applications (e.g. shipboard radar systems), the MIMICs must be placed in close proximity to high power microwave sources. In other situations, radiation from hostile sources (e.g. jammers) is used to disable microwave/millimeters wave equipment and components, protection for most circuits is provided by so-called T/R switches. However, these switches cannot always respond quickly enough to high power, short pulse inputs. This project is directed toward providing additional protection for MIMIC circuits against damage from high power, short pulse, radiation, including, the use of a portion of the MIMIC chip to provide the protection. If so, the impact on the cost, processing, yield and performance of the MIMIC chip must be minimal.

Phase I: Select one or more promising approaches to providing the needed circuit protection. Identify impact on cost of the overall system, size, weight and power supply requirements and whether or not any portion of the MIMIC chip itself will be used to provide protection.

Phase II: Demonstrate the usefulness of the proposed approach by building the proposed protection circuitry and demonstrating its ability to protect one or more classes of MIMIC circuits without imposing unreasonable cost increases or size, weight and power supply increases.

SB91-024 TITLE: Non-Destructive Material Evaluation to Determine Structural Defects and Predict Reliability

CATEGORY: Advanced Development.

OBJECTIVE: Development of in-process sensor technology and test methodology for non-destructive, real time evaluation of material structural properties during manufacturing.

DESCRIPTION: Manufacturing requires the real-time evaluation, both metals and semiconductor crystals, to determine structural properties, including an inspection for latent defects. Current evaluation techniques usually require contact with the material during testing and often require extensive set-up and evaluation time. For example, X-ray, ultrasonic and optical characterization have proven effective, but require off-line evaluations that utilize special facilities and increase cost. Feedback to manufacturing can be slow, resulting in additional cost. The establishment of real-time, on-line evaluation of material properties as an in-process control, integral to the manufacturing operation, would provide a more effective means of reducing manufacturing cost and improving product quality. The non-destructive evaluation techniques should apply to compound semiconductors, composites, or electronic materials.

Phase I: Determine the feasibility of non-destructive evaluation techniques and correlate the results of these techniques to the results of conventional approaches. Select and evaluate material samples from a representative defense manufacturing process and identify material defects that are related to failure modes. Establish material evaluation criterion for qualifying the material for a product application.

Phase II: Demonstrate the cost reduction, and increases in yield and throughput of a manufacturing line in defense manufacturing after application of selected evaluation techniques.

SB91-025 TITLE: Multiple Sensors to Control Chemical Deposition Processes and Plasma Etching of Semiconductors

CATEGORY: Advanced Development

OBJECTIVE: Development of sensor technology, with associated signal processing, for real-time control of the process variables affecting chemical deposition an etching of semiconductors.

DESCRIPTION: Chemical vapor deposition and plasma etching of semiconductors are complex manufacturing processes, requiring the control of multiple parameters to insure the repeatability and quality of the process. Currently, control parameters, such as pressure, temperature and gas flow rates, are set externally to the tractor and are monitored independently to ensure the stability of preset parameters. Conditions within the reactor, where the material is actually processed, are not directly monitored. Also, sensors within the reactor function independently, without detailed information from other sensors within the reactor. Sensors-based control could be significantly improved with a suite of synergistic sensors. Data from the multiple sensors could be integrated into a processor, guided by an analytical/empirical model, to ensure the process is following the prescribed optimum process.

Phase I: Select the process control variables using a process model as a guide. Evaluate sensor concepts, with the appropriate signal processor, to determine the optimum sensor/processor combination. Demonstrate the fusion of process control data from multiple sensors in a prototype reactor.

Phase II: Demonstrate an improved chemical deposition or etching process using the sensor suit integrated into a production compatible reactor. Demonstrate material quality and yield improvements relative to processing without the use of the sensor control.

SB91-026 TITLE: Designs for Multi-Spectral Infrared Imaging Systems

CATEGORY: Advanced Development

OBJECTIVE: Formulate and evaluate the design of an infrared focal plane array, with the associated signal processor, to detect radiation in multiple bands within the 1-14 micrometer infrared region.

DESCRIPTION: Infrared focal plane arrays can be made sensitive to radiation within abroad spectral band. This can be accomplished with a single material or with different materials sensitive to specific infrared bands. The organization of the focal plane for detection of the multiple bands and the signal processing associated with the detection of radiation in multiple bands must be developed.

Phase I: Develop a design of a multi-spectral infrared sensor. Evaluate the design with performance modeling of both the detector and the signal processor. Evaluate improved system performance under various atmospheric conditions and target scenarios.

Phase II: Evaluate the producibility of multi-spectral infrared focal plane designs. Assess material growth constrains and signal processing capabilities relative to the current capabilities. Fabricate signal processor chip designs and perform a laboratory evaluation to verify the performance predictions.

SB91-027 TITLE: Integrated Technology Computer Aided Design

CATEGORY: Advanced Development

OBJECTIVE: Develop novel approaches to reduce the cost, speed the testing, and accelerate the deployment of integrated Technology Computer Aided Design (TCAD) systems.

DESCRIPTION: The development of new semiconductor manufacturing technologies is a multi-disciplinary task. Engineers consider electrical, mechanical, thermal, and chemical properties as they develop a device architecture to meet a product requirement and develop the process to fabricate that architecture. This means using software tools, which were developed by a number of different individuals and companies, run on different platforms, and use proprietary data structures. Examples of TCAD tools include electrical circuit and device simulators, physical layout tools, process (deposition, etch, implant, etc.) simulation tools, thermal and reliability analysis, and yield estimators. The use of a common support infrastructure or "framework" has been proposed as a way to simplify the integration of those tools into a productive environment. The framework should support the use of industry standard data models and provide uniform access to services such as data management, tool invocation, communications, user interface, and operating system. Such frameworks have already been successfully demonstrated for integrated circuit design environments, but have yet to be applied to TCAD even though many of the requirements are the same.

Phase I: Define a detailed set of requirements for a TCAD framework. Evaluate existing framework technology and emerging industry standards for applicability to TCAD. Propose an approach to extending that technology into the TCAD arena and a demonstration of its utility for integrating TCAD tools.

Phase II: Develop the detailed functional and information models to support TCAD. Implement those models using off-the-shelf framework technology. Demonstrate the utility of the framework by integrating a number of TCAD tools from more than one commercial source into an integrated environment.

SB91-028 TITLE: High Speed Sensing Techniques to Determine the Surface Profiles of Materials and Components for Electronic Packaging

CATEGORY: Advanced Development

OBJECTIVE: this project develops hardware and techniques for real-time inspection of interconnections used in densely packed integrated circuits for multi-chip electronic modules.

DESCRIPTION: As signal processing and computing functions become more complex, circuits are being implemented in multi-chip modules. Reliable interconnections on these modules are essential to the successful implementation of the processing function. Inspection of the interconnections prior to the integration of the chips into modules is essential to manufacturing the electronic package. From several hundred to one thousand interconnections will be included in a typical possessing module. Real time inspection of these interconnections requires high speed signal processing to assess the spacing, alignment and, in some applications, the shape of each contact prior to the formation of the interconnection. An increase in the speed of he current inspection systems is necessary to achieve on-line evaluation of the electronic interconnections. Improvements in both the sensor array technology and the associated signal processing is necessary to implement a real time high speed inspection for electronic packages.

Phase I: Assess the various methods of achieving the speed required for real time inspection of interconnections for electronic packages. Evaluate the preferred approach in a laboratory breadboard before the completion of the first phase. Identify design trade-offs considering the sensor array, processing function, the speed and accuracy required for real time inspection, and the potential savings in packaging cost.

Phase II: Finalize the design and build a prototype system. Integrate the system into a manufacturing environment for real-time inspection of contacts for electronic packages. Document the performance of the inspection system

including the accuracy, speed, cost of the operation, and the savings in packaging cost achieved through integration of the inspection system into the manufacturing line.

SB91-029 TITLE: Infrared Focal Plane Design, with On-Focal Plane Signal Processing, for Multiple System Applications

CATEGORY: Advanced Development

OBJECTIVE: Design an infrared focal plane array with application to a generic family of tactical system applications.

DESCRIPTION: Infrared focal plane arrays (IRFPA) consist of a large number of individual infrared detector elements, organized in a specific configuration to meet particular system requirements. As a result, many IRFPA configurations are proposed, each with a unique detector configuration and associated signal processor design. Each of these focal plane array designs require custom drive electronics, read-out sequences and interfaces to off-focal plane electronics, which places a substantial non-recurring design and verification burden on each system application. In addition, the production quantities required of each particular design are not sufficient to achieve the cost benefits associated with volume production. A family of generic designs has the potential to achieve the production volume to substantially reduce cost.

Phase I: Design and model the performance of an IRFPA that meets multiple system requirements within a tactical mission area (e.g., missile seeker, infrared search and track, target acquisition). Evaluate the IRFPA design by modeling sensor performance using suitable parameters for the sensor system for each application. Design and model the performance of the modular drive electronics for the generic family of IRFPAs.

Phase II: Develop a breadboard demonstration of the modular drive electronics. Design and build the electronics module and demonstrate performance for a family of IRFPAs.

SB91-030 TITLE: In-Situ Sensing and Controlling of High Temperature Manufacturing Processes

CATEGORY: Advanced Development

OBJECTIVE: Development of non-contract techniques to measure and control high temperature manufacturing processes for semiconductors, composites, and material formed by rapid solidification processes.

DESCRIPTION: High temperature material synthesis requires the accurate measurement and control of the temperature of the material, including the temperature uniformity material. For real time process control, temperature measurements must be performed at temperatures as high as 1000 – 1500 degrees centigrade without disturbing or altering the material growth process. Accurate high temperature measurements under a diverse set of process conditions is essential to the improvements of material manufacturing processes for defense applications.

Phase I: Evaluate non-contact techniques to measure material at elevated process temperatures. Simulate process conditions for semiconductors, metals and composites to reproduce the manufacturing process. Correlate non-contact temperature measurements with a direct measure of material temperatures under the same processing conditions.

Phase II: Integrate the evaluation technique assessed in the first phase into a manufacturing process. Evaluate the influence of the process conditions on the accuracy of the temperature measurements. Document the material properties and cost reductions associated with the incorporation of the improved temperature measurement.

SB91-031 TITLE: Software Development tools for Computer Integrated Manufacturing Systems

CATEGORY: Advanced Development

OBJECTIVE: Develop software tools and methodologies which will aid in the specification, design and implementation of Computer Integrated Manufacturing (CIM) systems especially to support the manufacture of integrated circuits.

DESCRIPTION: with rapid growth in product complexities and intense international competition, manufactures are increasingly turning to CIM systems to help boost manufacturing yield, product quality, and factory utilization. Unfortunately, these systems often fail to meet their objectives or turn out to be much more expensive than anticipated. While general purpose Computer Aided Software Engineering (CASE), modeling, and simulation tools have provide CIM system are developers some leverage, their utility is often limited by their generality. Tools specifically tailored for developing CIM systems are needed which take advantage of emerging standards in various manufacturing segments. Tools, which provide the capability of representing, manufacturing requirements, provide for modeling equipment behavior and real time constraints, and assist in implementing reliable and distributed systems are also needed.

Phase I: Survey current work on tools and methodologies for developing and fielding CIM systems. Develop detailed requirements to support the development of CIM systems for semiconductor manufacturing. Specify a methodology for CIM system development and propose on or more software tools which implement all or part of that methodology.

Phase II: Prototype one or more of the proposed software tools. Demonstrate its utility by developing one or more subsystems of a semiconductor manufacturing CIM system. Refine the development methodology.

SB91-032 TITLE: Designs and Concepts for High Performance Uncooled Infrared Imaging Sensors

CATEGORY: Advanced Development

OBJECTIVE: Develop the technology for an infrared imaging sensor that operates at or near room temperature with the performance required for target acquisition, surveillance and man-portable imaging system requirements, and has the potential for application as a thermal imaging inspection system for manufacturing.

DESCRIPTION: Infrared imaging senores operating at cryogenic temperatures with sensitivity in the 3-20 micrometer spectral band have demonstrated the performance to meet imaging system requirements. The cooling required for these arrays often precludes their application in a manufacturing environment. Concepts for uncooled imaging sensors have been proposed and the feasibility of uncooled infrared sensors has been demonstrated for selected applications. However, the performance of the uncooled sensor must be improved before implementation in many applications, including inspection for defects in manufacturing. The sensitivity and resolution of the uncooled sensor must be increased to provide the performance necessary for both imaging and manufacturing inspection applications.

Phase I: Evaluate the performance of the uncooled imaging sensor for both imaging and manufacturing applications. Assess the thermal responsivity, noise and resolution assessed relative to proposed applications in both thermal imaging and manufacturing. Conduct a survey of the state of the art of uncooled sensors for manufacturing applications. Recommend improvements in sensor and signal processor performance, as necessary to meet manufacturing applications.

Phase II: Develop a prototype for both manufacturing and target acquisition applications based on the designs evaluated in the first phase. Document the performance of the uncooled array and thoroughly describe the cost benefits of thermal imaging inspection systems in manufacturing.

SB91-033 TITLE: Novel Materials for X-Ray Lithography Masks

CATEGORY: Advanced Development

OBJECTIVE: To Develop membrane/absorber lithography mask combinations compatible with high resolution definition and high structural stability.

DESCRIPTION: X-ray lithography will be used in the future to make semiconductor devices having features of 0.25 micrometers and below. The patterns are defined by proximity printing with x-rays of about one nanometer wavelength and x-ray lithography masks. Currently, the mask is made by pattering a thin film of high atomic number, such as gold, onto a thin membrane, such as silicon, and then bonding it to a quartz ring for handling purpose. Structural stability is required because of the extremely critical dimensions in advanced integrated circuits. Distortion, from stress and thermal effects, must be minimized. The materials should be compatible with the processing required to define the small features in the absorber layer. The thin membrane must support a pattern area of greater than 2 cm x 2 cm. Optical transparency of greater than 50% for the membrane is desired. Candidate membrane materials include silicon carbide and diamond; candidate absorber materials include tungsten and tantalum. The totality of mask fabrication will involve a sequence of discrete fabrication steps; any subset that fits reasonably will into an integrated plan will be considered.

Phase I: Select candidate materials and define processing steps. Develop a plan for how these may be integrated into a complete mask making process, evaluating effects between the various material properties and processing steps. Evaluate this plan against the many, varied requirements of masks in semiconductor manufacturing.

Phase II: Fabricate prototype samples and characterize. Deliver samples to third-parties for independent evaluation. Evaluate projected cost of appropriate subset in the mask fabrication sequence and under anticipated market conditions.

SB91-034 TITLE: Development of a Substitute for Highly Toxic Arsine Gas for Use in Fabrication of Gallium Arsenide Material

CATEGORY: Advanced Development

OBJECTIVE: To develop alternatives to arsine which will be readily accepted by existing and future industries using metal organic chemical vapor deposition (MOCVD) and gas-source molecular beam epitaxy (MBE) growth systems.

DESCRIPTION: MOCVD and MBE are accepted techniques for the growth of epitaxial layers. In particular, MOCVD of III-V semiconductor devices has been most successful and several production facilities are in operation. These include the production of microwave integrated circuits, laser diodes of compact disc players, photo cathodes for night vision goggles, and gallium arsenide (GaAs) solar cells. The principal weakness of current MOCVD methods is reliance on arsine as Group V source. Arsine is highly toxic and requires the installation of major facilities with expensive monitoring and safety equipment. Even though the technology for handing arsine is well developed, accidental release of a large quantity of arsine remains possible. Such a catastrophic failure could trigger the temporary or permanent shut-down of all facilities using arsine and interrupt the supply of devices that are critical for defense needs.

Phase I: Determine optimum conditions and parameters for growth of GaAs MOCVD material growth. Develop simple test device structure(s) and compare results achieved using alternate source with those obtained using standard MOCVD sources.

Phase II: Continue device development effort with a concentration on more complex device structures. Demonstrate device capabilities achieved using arsine replacement sources. Develop prototype growth system utilizing alternative environmentally safe sources as a replacement for arsine gas. Demonstrate prototype alternative source growth system capabilities including the potential for scale-up to large diameter (4 inch) substrates.

SB91-035 TITLE: Code Development Tools and/or Assistants for Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for software development tools and/or assistance to support development of software for scalable parallel computers that can be developed into functioning code for highly parallel multicomputers and multiprocessors.

DESCRIPTION: Innovative concepts are sought for developing software development tools and/or assistants of beta release quality for highly parallel multicomputers and/or multiprocessors. The software should 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.

Phase I: Provide a detailed specification of the proposed software-principles of operation, interfaces, display features, etc. Describe new or novel ideas or concepts. Describe use of proposed software; focus on its use in current or developing parallel computing environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (coded for scalable parallel computer) collection of algorithms, library routine, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in UNIX Tar format.

SB91-036 TITLE: Compiler Technology for Scalable Parallel Computers

CATEGORY: Exploratory development

OBJECTIVE: Explore novel ideas for advancing compiling technology for scalable parallel Computers.

DESCRIPTION: Innovative concepts are sought 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 scalable parallel systems.

Phase II: Develop the software module (coded for scalable parallel computer) which implements the new compiler technology. Demonstrate the effectiveness of the technology. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are e=required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

SB91-037 TITLE: Graphically Based Debugging Technology for Scalable Parallel Computers

CATEGORY: Exploratory development

OBJECTIVE: Explore novel ideas for advancing, graphically based debugging technology for scalable parallel computers.

DESCRIPTION: Innovative concepts are sought for advancing graphically based 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 (coded for scalable parallel computer) which implements the new debugging 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 hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

SB91-038 TITLE: Scalable Algorithms and Software Library Modules for Scalable Parallel computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for scalable algorithms and software library modules that can be developed into functioning code for highly parallel multicomputers and multiprocessors.

DESCRIPTION: Innovative concepts are sought for developing scalable algorithms and software libraries of beta release quality for highly parallel multicomputers and/or multiprocessors. The software should 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.

Phase I: Provide a detailed specification of the proposed software-collection of algorithms, library, or tool. Describe new or novel ideas or concepts. Describe use of proposed software; focus on its use in current or developing parallel computer environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (coded for scalable parallel computer) collection of algorithms, library routine, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

SB91-039 TITLE: Performance Analysis and Performance Tuning tools for Scalable Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for performance analysis and code tuning, particularly graphically based techniques, that can be developed into functioning code for highly parallel microcomputers and muliprocessors.

DESCRIPTION: Concepts are sought for innovative and novel ideas for developing, performance analysis and code tuning tools of beta release quality for highly parallel multicomputers and/or multiprocessors. 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.

Phase I: Provide a detailed specification of the proposed software-principles of operation, interfaces, display, features, etc. Describe new or novel ideas or concepts. Describe its use; focus on its use in current or developing parallel computing environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (code for scalable parallel computer) collection of algorithms, library routine, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII from and must be in Unix Tar format.

SB91-040 TITLE: Design and construction of Image Content-Addressable Databases

CATEGORY: Exploratory Development

OBJECTIVE: Development of techniques for constructing databases of images that can be retrieved based on the contents of the images.

DESCRIPTION: In many applications, users have large databases of images that they would like to be able to access based on the contents of the images. There are, however, many questions that must be answered before this could be done. For example, what information besides an image itself must be stored along with it? Where is this information to come from? Is it to be automatically or manually extracted from the image or is it to come from some other source? How is the user to specify the "contents" of images of interest?

Phase I: Theoretically analyze and answer the above and other relevant questions and develop techniques for accessing images based on that analysis.

Phase II: Explore and prototype implementation of the technique developed in Phase I.

SB91-041 TITLE: Large Knowledge-Based System Benchmarks

CATEGORY: Advanced Development

OBJECTIVE: To establish community wide benchmark tasks and quantitative measures of evaluation to facilitate the evaluation of knowledge representation languages, artificial intelligence based reasoning methods, and knowledge-based tools.

DESCRIPTION: Novel ideas and approaches are sought that will lead to community wide acceptance of benchmark tasks and quantitative measures of evaluation to facilitate the evaluation of knowledge representation languages, artificial intelligence based reasoning methods, and knowledge-based tools. It is anticipated that the project will encompass the specification of benchmark tasks and quantitative measures of evaluation as will as design specification of an instrumented test suite of tools. It is also knowledge base.

Phase I: Develop specifications for benchmark tasks, quantitative measures of evaluation, and instrumented test suite.

Phase II: Develop prototype instrumented test suite of tools and demonstrate the benchmark tasks and quantitative measures of evaluation on a candidate large knowledge base.

SB91-042 TITLE: Standards for Interoperable Knowledge-Based Systems

CATEGORY: Advanced Development

OBJECTIVE: To develop a candidate functional specification for an interoperability standard of a knowledge reasoning system integrated into a conventional system integrated into a conventional system software.

DESCRIPTION: Scalability and seamless integration of existing knowledge-based system approaches into conventional system software environments is a critical concern. The anticipated work will focus on the development of an interoperability standard.

Phase I: Develop a functional specification for an interoperability standard integrated into a conventional environment including, at a minimum, a state of the art, knowledge-based system and two or more relational databases. Describe an experiment to be performed in Phase II that includes quantitative measures of evaluation.

Phase II: Implement a prototype system based on the functional specification and evaluate the proposed standard based on quantitative criteria developed in Phase I.

SB91-043 TITLE: Tools to Support Building and Maintaining Shared Ontologies

CATEGORY: Advanced Development

OBJECTIVE: To develop specifications and proof of concept prototypes of a new set of knowledge-bases management tools to support sharing and reuse of knowledge bases.

DESCRIPTION: Novel approaches are sought that will enable a group of domain practitioners to share, reuse, and maintain a knowledge base. The anticipated research will focus on specific engineering considerations of temporal and spatial information where inherent domain constraints make the candidate domain challenging but tractable. Capturing design intent and rationale are important, since design knowledge may be used for other purposes (for example, to generate diagnostics, to forecast life cycle costs). The research should develop an ontological description of the domain-independent and dependent features which can be understood and used by practitioners in the domain. The research should develop the specification for intelligent tools that will assist in the creation and maintenance of these ontology's. A prototype set of tools should be developed and evaluated against a defined set of quantitative measures of evaluation.

Phase I: Describe the candidate domain, ontology, ontology creation and maintenance tools, and evaluation metrics.

Phase II: Develop a prototype ontology creation and maintenance tools and evaluate the prototype tools in the candidate domain.

SB91-044 TITLE: Evaluation Methods and Metrics for Image Processing and Understanding Algorithms

CATEGORY: Exploratory Development

OBJECTIVE: Development of methods for the evaluation of a wide variety of low, medium, and high level image processing and image understanding algorithms and techniques.

DESCRIPTION: Although there is general agreement that research in image processing and understanding has made great progress over the last fifteen years, there has been little progress in the development of methods for precisely characterizing and measuring this progress. In order to put the field on firm scientific footing and insure further significant progress, such methods are now needed.

Phase I: Summarize evaluation methods development to date with detailed analyses of their shortcomings as well as proposed set of new and improved methods.

Phase II: Explore and prototype implementation and demonstration of the new methods developed in Phrase I.

SB91-045 TITLE: Software Reverse Engineering Tools for Inclusion in Open Architecture Environments

CATEGORY: Advanced Development

OBJECTIVE: To develop advanced reverse engineering tool technology for software systems that can be experimentally integrated into emerging open-architecture software engineering environments. Specifically excluded are tools that implement a simple change of syntax from one language to another.

DESCRIPTION: High capability reverse engineering tools are sought that can support analysis of large scale existing systems, including detection of natural systems, component boundaries, establishing of abstract data types and invariants, and abstract characterization of function and performance. Acceptable proposals must produce

demonstration tool capabilities that could be integrated effectively into a variety of open architecture environment approaches such as software technology for adaptable reliable systems (STARS) and Arcadia. Acceptable proposals must also include descriptions of the extent of program analysis performed in order to extract information from existing codes.

Phase I: Provide a detailed description of tool capability, associated technical documentation, an engineering design, an analysis of related research, and an indication of external interface requirements. The design should include requirements for underlying environment substrates.

Phase II: Develop a prototype capability suitable for experimental integration into one or more of the software engineering environments currently being developed in association with DoD.

SB91-046 TITLE: Application of Image Understanding Techniques to Underwater Acoustic Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Application of Image Understanding (IU) techniques to the analysis of sonograms resulting from underwater acoustic signals.

DESCRIPTION: Interesting phenomena are frequently extracted by human visual examination of sonograms resulting from underwater acoustic signals. The purpose of this project is to find ways to help automate this process by applying established IU techniques to the interpretation of these sonograms.

Phase I: Define the sonogram understanding problem in IU terms and identify potential IU techniques that would be useful in solving this problem.

Phase II: Explore and prototype implementation and demonstration of the techniques developed in Phase I.

SB91-047 TITLE: Open Architecture Hypertext and Group Coordination Support for Advanced Software Design Environments

CATEGORY: Advanced Development

OBJECTIVE: To design a generic hypertext capability that can be included in software engineering environments for use in managing software configurations, software design information, and other large-scale complex structured objects.

DESCRIPTION: As part of an advanced software engineering environment design effort, generic interfaces for advanced hypertext user-interaction capabilities are sought. Successful interface design will enable multiple competing hypertext components to be developed that support the high capabilities required in a software design environment. Specifically sought is the development of asset of natural internal systems interfaces for hypertext front-ends, along with a validation experiment to demonstrate feasibility of the interface design. Acceptable proposals must (1) indicate hoe the propose technology will integrate into emerging open environment architecture conventions including those under development at DARPA, (2) include an analysis of related work, and (3) assess means to gain industry acceptance.

Phase I: Provide a detailed description of hypertext tool capability, associated interface design requirements, an analysis of related work in hypertext and associated interfaces, and an indication of external interface requirements. The design must include requirements for underlying environment substrates.

Phase II: Develop a prototype hypertext capability to enable validation of the interface designs. The capability must be suitable for eventual experimental inclusion in one of the software engineering environments currently being developed in association with DoD.

SB91-048 TITLE: Software Design Documentation Record Structural Design

CATEGORY: Advanced Development

OBJECTIVE: Preliminary designs for a common data structure to represent software design documentation and library data.

DESCRIPTION: Data elements I a software design record can include, for example, code fragments, test cases, requirements specification fragments, interface and architecture specifications, informal and formal design rationale, catalog and search points, metric data, hypertext paths, configuration and version data, access rights, and linage into repositories. DoD software systems often persist beyond tool life, which implies that design data must be tool-independent. The data structure must support trackable consistency, integrated version and configuration management, and appropriate visualization and hypertext support. Design generic interfaces for advanced software design documentation records. Provide for representation of software information well beyond that represented through existing mechanisms such as through the DoD CALS standard and DoD-STD-2167A. Develop a set of natural internal system interfaces for software documentation information. Acceptable proposals must (1) indicate how the proposed technology will integrate into emerging open environment architecture conventions including those under development at DARPA, (2) include an analysis of related work, and (3) assess means to gain industry acceptance.

Phase I: Develop a detailed description of requirements for the design record data structure, a feasibility study for implementation, associated software environment architectural requirements, and an analysis of related work in software documentation management.

Phase II: Develop a prototype representation for software design records to enable validation of the interface designs. This capability must be suitable for eventual experiment inclusion in one of the software engineering environments currently being developed in association with DoD.

SB91-049 TITLE: Robust Fusion of Mulit-Spectral and Multi-Temporal Images

CATEGORY: Exploratory Development

OBJECTIVE: Development of techniques for fusing together information gathered form temporal sequences o images and/or images taken using different parts of the frequency spectrum.

DESCRIPTION: Images formed from sensors working at different parts of the spectrum provide different types of information about a scene. Major improvements in the quality and variety of such sensors provide an opportunity to build image understanding systems that take advantage of the availability of these new sensors and the additional information that they provide. Temporal sequences of image scan provide additional information about changes taking place in a scene.

Phase I: Develop basic techniques for doing the type of image fusion described above.

Phase II: Explore and prototype implementation and demonstration of the techniques developed in Phase I.

SB91-050 TITLE: Modular Open Architecture Intelligent Controllers for General Purpose Machine Tools

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel concepts for open architecture machine tool controllers, using, emerging RISC or parallel processors, with emerging NGC compatible software architectures.

DESCRIPTION: Innovative concepts are sought for developing modular, open architecture intelligent controllers utilizing advanced RISC or parallel processors to implement extremely low periodicity for machine tools.

Phase I: Provide a detailed specification of the proposed software –principles of operation, interfaces, information model, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed system, focusing on its use in large scale machine tool environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed machine tools in a seamless, scalable fashion utilizing the specification developed in Phase I. Demonstrate scalability of approach over several interfaces, one of which must be ling distance networked communications. Develop a user manual which clearly descries any external interfaces or requirements, how o link additional machine tools to the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered I ASCII form and must be in Unix Tar format.

SB91-051 TITLE: Improvements to Peripheral Security of Timeshare System

CATEGORY: Exploratory Development

OBJECTIVE: Improvements to peripheral security of timeshare system.

DESCRIPTION: Authentication of users of timeshare systems is key to the prevention of intrusion. Improved algorithms and authentication technology are sought for user authentication as well as system authentication for network services such as: login, rlogin, rep, ftp, rsh, nfs.

Phase I: Provide detailed specification of the intended use and structure of the proposed security measure with complete interface definition.

Phase II: Develop the prototype of the security measure defined in Phase I including users manual. Deliver source and object in UNIX Tar format.

SB91-052 TITLE: Computer Supported Cooperative Work Software Architecture Design for Mechanical Design and Analysis

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel scalable software architectures for computer supported cooperative design of mechanical parts and assemblies.

DESCRIPTION: Innovative concepts are sought for developing and analyzing software architectures for scalable, distributed computer supported cooperative design of mechanical parts and assemblies. Concepts must include initial concept design, geometric design, parametric design, mechanical analysis, manufacturing analysis, and assembility analysis. Concepts must be descried 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 software-principles of operation, interfaces, display features, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed system, focusing on its use in large scale design environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed design tools in a seamless, scalable fashion. Demonstrate scalability of approach over several interfaces, one of which must be ling distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, and hoe to use the architecture to link additional design tools to the system. A

hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered I ASCII form and must be in Unix Tar format.

SB91-053 TITLE: Design Documentation Record Architecture in Mechanical Computer Aided Design Environment

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel design record specifications and descriptions supporting design history, design issues, and life-cycle design decisions for Mechanical Computer Aided Design (MCAD) Environments.

DESCRIPTION: Innovative concepts are sought for developing design documentation record software architectures for scalable, distributed computer supported cooperative design of mechanical parts and assemblies. Concepts should include initial concept design, trade analyses, geometric design, parametric design, mechanical analysis, manufacturing analysis, process planning, and assembility analysis. These 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 design documentation record structure – principles of operation, interfaces, information model, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed design record; focusing on its use in large scale design environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed design tools in a seamless, scalable fashion utilizing the specification developed in Phase I. Demonstrate scalability of approach over several interfaces, one of which must be long distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, and how to use the design record to link additional design tools to the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in UNIX Tar format.

SB91-054 TITLE: Integration of Multi-Spectral Sensors in Modular, Open Architecture Controllers for Precision Control of Metal Cutting Machinery

CATEGORY: Advanced Development

OBJECTIVE: To develop novel concepts for integrated, multi-spectral sensor packages specifically targeting increased dimensional accuracy and surface quality of machining processes using existing machine tools.

DESCRIPTION: Innovative concepts are sought for developing integrated multi-spectral sensor packages, including acoustic, thermal, piezeo-electric vibration, velocity and torque sensors for active real-time tool wear monitoring and control in conjunction with Modular, Open Architecture Intelligent Controllers for machine tools.

Phase I: Provide a detailed specification of the proposed software—principles of operation, interfaces, information model, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed system, focusing on its use in large scale metal cutting environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed cutting machines in a seamless, scalable fashion utilizing the specification developed in Phase I. Demonstrate scalability of approach over several interfaces, one of which must be long distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, and how to use the design record to link additional design tools to the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in UNIX Tar format.

SB91-055 TITLE: Novel Applications of Superconductor Technologies to Satellites

CATEGORY: Exploratory Development

OBJECTIVE: Apply superconductor technologies to reduce the size, weight, power consumption, and/or cost of satellite subsystems and components; improve the performance of current state-of the-art systems; and facilitate new capabilities not previously possible other technologies.

DESCRIPTION: Super conducting materials possess unique physical properties (perfect diamagnetism, high current density and magnetic field capabilities, dissipation less conduction, etc.) which are not available in other materials. Advanced over the past five years have reduced high temperature superconductors (Tc > 77°K) and the promise of room temperature materials. The potential exists for no cryogenically cooled devices to operate in the super conducting state under ambient conditions in space (either present materials or higher Tc materials). Potential application areas of interest for space systems include RF devices, sensors, hybrid microelectronics (super/semiconductor integrated circuits), superconductor device based microelectronics, and others. Examples of potential advantages derivable from these emerging technologies include faster microelectronic device switching times with reduced thermal dissipation leading to greater packaging densities; smaller, lighter electronic components that dissipate less energy as waste heat; and sensors with improved sensitivities vis-à-vis other technologies. Additionally, novel application in areas such as propulsion, spacecraft stabilization and attitude control, high density energy storage devices may facilitate new or improved capabilities for spacecraft. For example, spacecraft might be magnetically stabilized in attitude and/or spin rate by super conducting magnetorquers, and in principle sufficiently strong magnetic gradient forces may be developed in the earth's field to propel a spacecraft (with low thrust but very large specific impulse).

Phase I: Develop a super conductor application concept to meet one or more of the research objectives. Investigate key scientific and systems engineering considerations to provide: (1) theoretical justification of the proposed concept; (2) notional space system implementation concept, with emphasis on the effects of the space environment (radiation, thermal control out gassing, etc.); (3) advantages of the proposed concept over alternative technologies; and (4) discussion of utility and significance for national defense space systems.

Phase II: Estimate the cost to perform a laboratory proof-of-principle demonstration of the proposed concept and a rough order of magnitude cost to perform a space-based demonstration.

SB91-056 TITLE: Shape Memory Alloy Material Development for Actuators

CATEGORY: Exploratory Development

OBJECTIVE: Develop shape memory alloys with properties and stock sizes and configurations which are not currently available. The ultimate goal of this effort will be to develop actuators for use in one or more naval applications.

DESCRIPTION: DARPA is interested in the development of quiet, self-contained actuator technology which utilizes shape memory alloy (SMA) materials for naval applications. The material used at present is a nitinol (Ni-Ti) alloy which is available as wire with diameters of 0.003 – 0.010 inch (0.08 – 0.25 mm). Future applications of this technology are limited by the load capacity, the life cycle duration and the cycle frequency of these wires. The cycle frequency is primarily limited by cooling rate. To mitigate these limitations DARPA is interested in the development of shape memory alloy materials with any or all of the following properties.

(1) Alloys which transition form austenite to marten site and back to austenite over temperature range (as low as 1°C).
(2) Alloys which transition at high temperatures (up 150°C).
(3) Alloys with life cycles of 10 – 100 million cycles without degradation of performance and strength.
(4) Alloys with working strength up to or exceeding 100,000 psi.
(5) Stock with cross sectional areas up to 0.1 sq. in. (65 sq. mm).
(6) Stock in other configurations with large surface to volume ratios such as foil, flat stock, tubing, or wire rope.

Phase I: The results of the Phase I effort should include delivery of one or more samples of SMA material.

Phase II: The Phase II effort would include delivery of a sufficient quantity of material to develop prototype actuators and could include the design and constriction of prototype actuators.

SB91-057 TITLE: In-Situ Direct Vorticity Measurement System

CATEGORY: Advanced Development

OBJECTIVE: Develop a non-intrusive system for directly measuring the vorticity vector field around submerged vessels.

DESCRIPTION: DARPA is interested in locating sources of vorticity and the evolution of vorticity shed from surfaces or large scale underwater vehicles. Emerging laboratory-scale optical techniques for direct, non-invasive measurement of vorticity vectors can potentially be further developed to satisfy this need. An instrument that can be mounted either within a test vehicle or outside of the test facility and probe the vorticity field around the vehicle is desired. The instrument should ultimately be capable of rapidly measuring all three components of the vorticity vector at specified points in the flow field and of providing second order moments of vorticity fluctuations. Spatial resolutions as small as the Kolmorgorov micro scale is desirable.

Phase I: Demonstrate the feasibility of scaling up an existing laboratory measurement system to meet DARPA requirements.

Phase II: Develop, deliver, and demonstrate system at a selected test side.

SB91-058 TITLE: Innovative Underwater Launch Concept for an Endurance Unmanned Aerial Vehicle

CATEGORY: Advanced Development

OBJECTIVE: A proof-of-concept demonstration of the underwater launch of an endurance unmanned aerial vehicle (UAV).

DESCRIPTION: Technologies are rapidly maturing for UVA platforms and their sensors. A practical implementation of a UVA underwater launch concept would extend the operational capabilities of endurance UAVs.

Phase I: Illustrate a monitorial launch concept by developing a design which clearly articulates the concept's features.

Phase II: Prove the concept's viability by designing and developing a working model and demonstrating its practically relative to an endurance UVA and its underwater host platform.

SB91-059 TITLE: Multi-Sensor Management Technologies for a High Altitude Long Endurance Unmanned Aerial Vehicle

CATEGORY: Advanced Development

OBJECTIVE: A generic multi-sensor management technique optimizing the capabilities of high altitude long endurance (HALE) unmanned aerial vehicle (UAV) systems over a broad range of mission application and operating environments.

DESCRIPTION: Miniaturization of surveillance sensors coupled with other HALE UAV avionics advancements are expanding automated mission capabilities. Multi-spectral payload onboard management techniques are needed to complement these developments.

Phase I: Illustrate multi-sensor management by designing an onboard management technique which is applicable to a variety of sensors and compatible with a HALE UVA.

Phase II: Demonstrate the management process using existing/simulated platform and sensor characteristics to illustrate effective sensor cross cueing and overall optimal sensor coverage.

SB91-060 TITLE: New Approaches to Long Wavelength Infrared Imaging Devices

CATEGORY: Basic Research

OBJECTIVE: To explore new materials and device structures to provide an alternative to mercury-cadmium-telluride (MCT) for fabricating staring infrared imagers capable of operating in the 8 to 12 micrometer atmospheric window.

DESCRIPTION: There is a need to identify and demonstrate the feasibility of new materials, systems or device structures that respond to long wavelength infrared radiation. The materials or devises of interest must have a potential advantage over MCT based detection systems. The advantage could be derived from projected lower cost, simpler fabrication technology, better uniformity or any other significant characteristics that is significant to infrared imaging arrays. Preferably, the new system should have an advantage in more then one of the before mentioned factors.

Phase I: Identify and fabricate a structure that allows basic physical measurements, from which array performance can be predicted.

Phase II: Design and fabricate an infrared imaging array, with at least 64 by 64 pixels. Characterize the array performance over the 8 – 12 micrometer band.

SB91-061 TITLE: Diode Pumped Up conversion Lasers in the Blue-Green Wavelength Region

CATEGORY: Basic Research

OBJECTIVE: To develop diode pumped solid state lasers in the blue-green wavelength region, based on up conversion of energy stored in long-lived, rare earth ion states.

DESCRIPTION: Up conversion lasers are a new class of lasers to obtain visible wavelength without the need for external nonlinear processes for wavelength without the need for external nonlinear processes for wavelength conversion from the output of Nd:YAG lasers. Wavelengths ranging from the violet to deep red can be obtained from energy stored in long lived states of rare earth ions through the up conversion process. Most require on or two pump photons in the red or near infrared region. The pump photons can be obtained from laser diode arrays tailored in output wavelength to the specific crystal. This program seeks to demonstrate the possibility of new up conversion lasers involving rare earth ions other than those demonstrated to date. Specific wavelength outputs to be demonstrated are in the blue-green region of the visible spectrum.

Phase I: Identify and demonstrate up conversion lasers in the blue-green wavelength region in rare earth doped laser crystals other than those demonstrated to date.

Phase II: Demonstrate energy scale up and determine the diode pumping requirements of the up conversion lasers demonstrated in Phase I.

SB91-062 TITLE: Organic Nonlinear Materials for Wavelength Conversation

CATEGORY: Basic Research

OBJECTIVE: To develop new nonlinear organic materials for efficient wavelength conversion.

DESCRIPTION: Organic materials have high nonlinear coefficients and higher damage thresholds compared to inorganic compounds. This program is to examine new classes of organic compounds, other than those reported to date. The goals of this program are: 1) synthesis and characterization of relevant crystalline and nonlinear optical properties; 2) development of growth techniques; and 3) demonstration of efficient wavelength conversion and characterization of damage thresholds.

Phase I: Identify and characterize new nonlinear organic metatarsals other than those reported to date.

Phase II: Develop growth techniques, demonstrate efficient wavelength conversion and characterize damage thresholds.

SB91-063 TITLE: Multi-Frequency Laser Materials

CATEGORY: Basic Research

OBJECTIVE: To develop laser materials with multi-wavelength output.

DESCRIPTION: Self frequency doubling of fundamental wavelength in Nd: YAB type crystals has been reported. This program seeks to develop laser materials, with multi-frequency outputs other than those already reported, either continuous wave or Q-switched. Such laser crystals can be diode laser pumped or with inexpensive sources with output tailored to match the broad absorption lines of the laser materials. Such pump sources must be compact, efficient and comparable to laser diodes.

Phase I: Identify and characterize multi-frequency output laser materials.

Phase II: Further develop laser materials identified and characterized in Phase I. The efforts will address stable laser operation and crystal growth techniques.

SB91-064 TITLE: Using Diode Lasers for Compact Eye-Save Laser Radar

CATEGORY: Exploratory Development

DESCRIPTION: This program seeks to develop compact, low cost eye-safe laser radar using 1.54 micrometer laser diodes. The laser radar system will have numerous applications that require eye save operation. This program will address the conceptual design, component development issues, and breadboard integration and filed demonstration of the concept.

Phase I: Develop conceptual designs and systems analysis of eye-safe laser radar using 1.54 micrometer laser diodes.

Phase II: Based on the results of Phase I study, develop bread board laser radar system and demonstrate in the field.

SB91-065 TITLE: Detection and Analysis of Random-Pulse Ultra-wide Band Signals

CATEGORY: Exploratory Development

OBJECTIVE: The development of an ultra-fast signal processor that can analyze random impulse signals.

DESCRIPTION: Repetitive impulse signals can be detected quite accurately if they are properly stored and integrated. On the other hand the detection and the analysis of random impulse signals are not so straightforward. Conventional electronics can detect and analyze single electromagnetic signals with bandwidths up to several GHz. Above that, even propagation through transmission lines or connectors can degrade the signal to be analyzed. Ultra fast techniques (e.g. electro-optical) that do not require integration are necessary.

Phase I: Develop the methodology of the detection scheme.

Phase II: Demonstrate detection techniques and feature with a proof-of principle experiment.

SB91-066 TITLE: Low Temperature Diamond Film Deposition for Thermal Management

CATEGORY: Advanced Development

OBJECTIVE: To develop low temperature Chemical Vapor Deposition (CVD) processes for high thermal conductivity diamond films.

DESCRIPTION: The development and application of high speed electronic devices is often limited by self-generated thermal loads. As the speed of these devices increases, heat dissipation and thermal management become increasingly important and frequently restrict system design. Diamond films deposited directly on microelectronic devices are projected to be very effective in spreading and dissipating the generated heat to the surrounding package. However, current CVD diamond processes operate at fairly high substrate temperatures (ie. Approximately equal to 800°C) to achieve high purity and thermal conductivity. Therefore, low temperature deposition processes that would be compatible with silicon and gallium-arsenide devices, are of considerable interest.

Phase I: Develop and demonstrate low-temperature diamond deposition process and confirm by Raman spectroscopy and X-ray/electron diffraction analysis.

Phase II: Scale-up process, measure diamond thermal conductivity, and diamond coat silicon and gallium-arsenide integrated circuit devices.

SB91-067 TITLE: Advanced On-Line Sensor for Materials Manufacturing, Process Control, and Quality Assurance

CATEGORY: Exploratory Development

OBJECTIVE: To develop and apply innovative process and product quality in-situ sensors, for monitoring and controlling key process parameters during chemical vapor deposition (CVD) of diamond.

DESCRIPTION: Close tolerance manufacturing control and on-line quality assurance require in-situ sensors to measure and control key process parameters and/or the state of the material in production. The chemical vapor deposition of diamond is a process with significant potential application to DoD systems, however, at present this empirical process often produces anomalous results and undesirable film characteristics. It is anticipated that on-line sensing of key parameters of product qualities such as gas compositions and concentrations, or diamond film orientation and crystallite size will enable closed-loop feedback control of the process and insure product quality. Innovative sensing concepts with potential for application in a manufacturing environment are of particular interest.

Phase I: Demonstrate one or more in-situ sensing approaches for CVD diamond processing.

Phase II: Develop sensor (s) and apply in CVD diamond processing system and correlate sensor data with diamond film qualities.

SB91-068 TITLE: Applications of Data Fusion to Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To distinguish objects of interest in signal processing environments through application of data fusion principles.

DESCRIPTION: There are many signal processing environments where no single measure of the data can distinguish the objects of interest. However, by computing many different properties of the signal it may be possible to "fuse" the results to distinguish the objects of interest.

Phase I: Determine a signal processing problem of current interest to the DoD and the properties computations that could distinguish objects of interest. Indicate a fusion method for making the ultimate signal identification.

Phase II: Using off the shelf hardware, construct a prototype to demonstrate the results of Phase I.

SB91-069 TITLE: Intelligent Control Related to Materials Manufacturing

CATEGORY: Exploratory Development

OBJECTIVE: To create a method of controlling a material manufacturing task and describe the nature of sensors and methods that can be used to effectively control the process.

DESCRIPTION: Choose a materials manufacturing task and describe the nature of sensors and methods that can be used to effectively control the process.

Phase I: Determine a problem, the senor locations and outputs, and provide a design for an intelligent controller.

Phase II: Produce a demonstration or numerical simulation to verify the design.

SB91-070 TITLE: Novel Concepts for Processing Structural Ceramic Composites

CATEGORY: Exploratory Development

OBJECTIVE: To synthesize and process fiber-reinforced and whisker-reinforced ceramic matrix composites, with the goal of increasing room temperature and elevated temperature toughness and strength, to values substantially above those for monolithic ceramic.

DESCRIPTION: Ceramic composites are of interest to the DoD for a variety of applications: high temperature structural materials for aircraft and missiles, armor, gun barrel liners, and a variety of wear-resistant applications. Novel processing techniques to produce net shape low cost composites will be given high priority.

Phase I: Process ceramic composites to dense bodies, determine room temperature toughness and strength and conduct microstructural characterization.

Phase II: Optimize mechanical properties (strength, toughness, creep resistance) at both room temperature and elevated temperature. Fabricate and evaluate demonstration components.

SB91-071 TITLE: Processing of Molybdenum Disilicide ($moSi_2$) Matrix Composites

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative, low-cost processing approaches to production of $MoSi_2$ composites and to develop high-temperature, material, property correlations to these processing approaches.

DESCRIPTION: Molybdenum Disilicide is known to have extraordinarily high temperature environmental resistance and reasonably low density; however, the lack of room temperature fracture toughness and poor high temperature creep resistance has severely limited its structural applications. However, this material is an excellent candidate for development as a matrix material in high-temperature structural composite systems. Innovative, low-cost processing concepts are desired for processing of $MoSi_2$ matrix composite systems for structural applications.

Phase I: Identify one or more composite systems and innovative low-cost processing approaches. Develop a plan for processing the material and perform analytical evaluation of the properties of the composite system.

Phase II: Develop and demonstrate the composite processing system and measure product material properties.

SB91-072 TITLE: Development of $C0_2$ Rejecting Electrolytes for Fuel Cells

CATEGORY: Exploratory Development

OBJECTIVE: To develop electrolytes that will effect the rejection of by-products of electrochemical occurring at the anode of hydrocarbon fuels and methanol. In particular, the electrolytes must be compatible with the anode catalyst and be highly efficient in the rejection of $C0_2$ and perform well in experimental fuel cell stacks.

DESCRIPTION: The direct oxidation of methanol and other hydrocarbon fuels will permit a fuel cell to be operated without a reformer, which in turn will provide a higher system power density at lower temperatures (about 100^0C). A key problem with available electrolytes is their failure to efficiently reject the products of oxidation and especially CO_2.

Phase I: Develop candidate electrolytes that show promise for efficient rejection of electrochemical oxidation products.

Phase II: Incorporate the candidate electrolytes developed under Phase I in direct oxidation at the anode fuel cell stacks, including methanol, and demonstrate their efficiency and performance.

SB91-073 TITLE: Super Acid, Solid Electrolyte Catalysts for Fuel Cells with Direct Oxidation of Hydrocarbon Fuels

CATEGORY: Exploratory Development

OBJECTIVE: To develop super acid, solid electrolyte catalysts for fuel cells that will affect the direct oxidation of methanol and hydrocarbons ate the anode with high efficiency. Candidate catalysts will be tested in near-ambient temperature experimental fuel cell stacks and their performance and efficiency will be evaluated.

DESCRIPTION: The direct oxidation at the anode of methanol and hydrocarbon fuels may be affected by the use of super acids in a solid electrolyte environment. This would result in the development of fuel cells with high power density which operate at near-ambient temperatures.

Phase I: Develop candidate superacids and compatible electrolytes.

Phase II: Incorporate the candidates from the Phase I program into an experimental fuel cell stack and demonstrate their performance and efficiency.

SB91-074 TITLE: Fuel Cell Catalysts for Direct Oxidation of Methanol

CATEGORY: Exploratory Development

OBJECTIVE: To develop catalysts that will efficiently effect the oxidation of methanol at the anode of near ambient temperature fuel cells. Candidate catalysts will be tested in an experimental fuel cell stack and their performance and efficiency will be evaluated.

DESCRIPTION: The direct oxidation of methanol allows a fuel cell to be operated without a reformer leading to more rapid start-up times and higher system power density. At the present time the main drawback in methanol electrocatalysis is the formation of strongly adsorbed intermediates that block or inhibit the reaction. New supported catalysts are sought which will significantly improve current density and enhance long-term operation without unduly increasing system cost. Approaches that integrate a fundamental understanding of the catalysis and surface chemistry with novel electrode structure design, fabrication and evaluation will receive serious consideration.

Phase I: Develop candidate catalysts that show promise for incorporation into methanol fuel cells.

Phase II: Build and test a prototype fuel cell that incorporates the catalysts developed under the Phase I program.

SB91-075 TITLE: Assessment of Materials, and Component Development Using Advanced Combat Models

CATEGORY: Advanced Development

OBJECTIVE: To provide a method for measuring cost effectiveness of the insertion of advanced materials and structures into modern weapon systems.

DESCRIPTION: In the development of components and subsystems for weapon performance enhancement, modeling of battlefield results has never been carried out to develop a true cost benefit analysis. This can be accomplished with advanced decision methodology specifically designed for incorporating results from computer modeling of force-on-force wargaming. This would effectively capture and treat combat simulation results in the form of probabilistic and well-defined variables, thereby making the tool available to development scientists.

Phase I: For an appropriate component set determine how performance information will be selected, how it will be inserted into a battlefield model, and how cost-benefits will be analyzed. Select an appropriate decision methodology and conduct analysis to demonstrate the suitability of the method to handle wargaming results. Evaluate a hypothetical weapon system enhancement with actual model runs, obtaining a cost-benefit analysis.

Phase II: Perform extensive battlefield modeling of an approved selection of components, resulting from advanced materials and structures development. Conduct a sensitivity analysis based on possible ranges of materials properties in the components, to allow judgments to be made on the criticality of materials development. Provide an assessment of the utility of the developed decision method for guiding materials and structures research and development. Document the methodology for efficient technology transfer to agency users.

SB91-076 TITLE: Application of High Temperature Superconductors to Electronic Circuitry

CATEGORY: Advanced Development

OBJECTIVE: To determine how high temperature (nominally 80K) superconducting materials can be introduced into electronic circuitry to enhance overall properties of signal dispersion, frequency response, packing density, reduced crosstalk and reduced power dissipation.

DESCRIPTION: The recent discovery of high temperature ceramic oxide superconductors has important implications in advancing the capabilities of electronic components and circuitry. The phasing of this insertion into electronics probably will begin with the replacement of normal metal interconnects with superconducting leads and transmission lines.

Phase I: Select an appropriate electronics package and determine how a computer-aided-design code can be modified to accommodate superconducting leads and transmission lines. Determine how the code must be adjusted to optimize the layout geometry according to the special properties and processing requirements of superconducting materials. Prioritize the types of superconducting insertions and evaluate their cost-benefit within the upgraded electronics package.

Phase II: carry out the modifications of a CAD code to insert superconducting leads and transmission lines, from Phase I. Compare the predicted performance of the electronic circuitry to that of the standard electronics package. Translate the code into design instructions for the layout of the superconducting circuitry. Contract the deposition and configuration of the superconducting circuitry and evaluate its performance relative to the standard circuit.

SB91-077 TITLE: Thin Film, High Dielectric Constant, Micron Sized Capacitor Materials

CATEGORY: Exploratory Development

OBJECTIVE: To explore high dielectric materials for use in thin film capacitors for semiconductor electronics, and to develop deposition techniques that yield high quality capacitors using these materials.

DESCRIPTION: thin film capacitors in DRAMs and other electronics take up significant area. In order to reduce the area consumed by these devices, the capacitors are grown in trenches. DARPA is interested in exploring alternative materials with significantly higher dielectric constants that could be used to produce very small area capacitors without the necessity of growing them in trenches.

Phase I: Identify candidate high dielectric materials which are likely to be compatible with semiconductor electronics, both during processing and longterm use.

Phase II: develop processing techniques, including deposition and patterning, to produce thin film, high dielectric capacitors using the materials identified in Phase I. Electrically characterize the resulting capacitors. Explore any significant obstacles to scaling-up the process to high density electronics.

SB91-078 TITLE: Neural Applications Leading to Hardware Implementation

CATEGORY: Exploratory development

OBJECTIVE: To design and develop prototype neural net hardware systems for specific applications.

DESCRIPTION: DARPA is interested in receiving innovative proposals leading to the implementation of artificial neural network (ANN) methods using dedicated hardware. Each proposal should address a specific ANN application which: (1) is of clear importance to the Department of Defense, (2) has already been demonstrated using software simulations on general purpose computers, and (3) is expected to improve in performance and/or utility through implementation in dedicated ANN hardware.

Phase I: Verify the feasibility and anticipated advantages of implemented the chosen ANN application dedicated hardware, and develop a detailed plan and design for doing so.

Phase II: Accomplish the hardware implementation, including all needed ANN training and testing, and evaluate and demonstrate the performance and utility of the resulting system in relation to a specific military application.

SB91-079 TITLE: Device Phenomena Unique to Sub-Micrometer Devices

CATEGORY: Basic Research

OBJECTIVE: To identify and study novel phenomena unique to sub-micron electronic devices.

DESCRIPTION: As electronic device dimensions shrink, new phenomena appear. Some of these effects are classical (e.g. short channel effect) and some are quantum mechanical (e.g. resonant tunneling). Because DARPA continues to pursue programs to rise the density of electronics, DARPA is interested in exploring and understanding effects that can be used for making novel ultra-small devices or for producing more functionality per unit area of the chip even if the device size remains the same as present devices. Similarly, DARPA is interested in methods of circumventing deleterious effects in known devices as their dimensions are reduced.

Phase I: Identify phenomena that significantly influence existing electronic device performance as the device is reduced in dimensions or novel phenomena in sub-micron structures that could be used as the basis of new types of electronic devices.

Phase II: Explore these device phenomena theoretically/or experimentally.

SB91-080 TITLE: Integrated Spatial Light Modulators for Optical Processing with Incoherent Light

CATEGORY: Exploratory Development

OBJECTIVE: To develop a spatial light modulator that will respond to an incoherent light input and can be used in subsequent coherent optical processing.

DESCRIPTION: Materials that respond to incoherent light input with a refractive index change can convert 2D images into a coherent light representation.

Phase I: Prove that the candidate material will respond in the desired manner with sufficient sensitivity. Show compatibility to integration.

Phase II: Fabricate integrated spatial light modulator. Operate as optical processor.

SB91-081 TITLE: Reproducible Growth Techniques for Ultra Thin Epitaxial Multilayers on III-V Substrates

CATEGORY: Advanced Development

OBJECTIVE: To perfect growth techniques for ultra thin (20-2500 A) multilayers on III-V substrates at reasonable thruput. Custom design wafers should be available upon the successful conclusion of this program at low cost and high reproducibility.

DESCRIPTION: The state of the devices in optoelectronics and electronics requires semiconductor materials engineered with thin layers and abrupt interfaces. At present, these materials are only available from individual researches t very high cost marginal reproducibility.

Phase I: Demonstrate proposed growth technique to clearly establish capability to grow sample material with thin film and abrupt interfaces.

Phase II: Demonstrate growth technique which produces high quality materials and can accommodate custom designs. Reasonable throughput should be achieved to enable low cost.

SB91-082 TITLE: Chemical Biological Warfare Treaty Verification

CATEGORY: Exploratory development

OBJECTIVE: To develop methodologies and technologies for enhanced US capability in Chemical Biological Warfare (CBW) monitoring and treaty verification.

DESCRIPTION: improvements are needed in conventional and national capabilities for overt/convert monitoring of chemical and biological warfare (CBW) weapons production, munitions stockpiling and demilitarization. Also needed are an analysis of alternative manufacturing processes and their impact on the flow of raw material and production by-products/waste products. Use scenarios may range from (overt) routine and challenge on-site inspections to (cover) continuous monitoring of suspected production facilities. Efforts will focus on central research issues.

Phase I: develop proposal which identify/describe hypothetical use scenarios (where appropriate) and describe novel methodological and/or technological insights.

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

SB91-083 TITLE: Advanced Military Medicine

CATEGORY: Basic research

OBJECTIVE: Development of generic methods for the design and synthesis of prophylactics and therapeutics suitable for the prevention and treatment of viral, bacterial and parasitic disorders.

DESCRIPTION: The prevention and treatment of infectious diseases commonly found in combat environments is complicated: 1) by the general lack of capacity for rational drug design, 2) by the inordinate time lag between characterizing of a pathogen and the introduction of putative therapeutics into human clinical trails, and 3) by unacceptable risks of negative side effects. Proposal are sought to develop methodologies/technologies capable of dealing simultaneously with all three issues.

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

Phase II: Provide initial in-vitro/in-viva proof –of-concept demonstrations, as appropriate, for central issue(s).