DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submitting Proposals

The responsibility for carrying out the DARPA SBIR Program is vested in the Program Management Office. The DARPA Coordinator and Manager of the program is Dr. John K. Meson.

DARPA invites the small business community to send proposals directly to DARPA under the following address:

Defense Advanced Research Projects Agency
Program Management Office
ATTN: Dr. John K. Meson
1400 Wilson Boulevard
Arlington, VA 22209

The proposals will be processed in the Program Management Office and distributed to appropriate technical offices for evaluation and action.

DARPA identified 22 technical topics to which the small business can respond. A brief description of each topic is included below.

SB86-001 TITLE: Magnetic Imaging Seeker

DESCRIPTION: Most military targets of interest contain large amounts of magnetic materials. Conventional seeker technology for negating tanks, artillery and other similar weapons relies on exploitation of optical millimeter wave and infrared signatures for detection of the target in clutter. These seeker concepts require sophisticated electro-optical imaging concepts that degrade in high clutter and certain combinations of target and weather conditions. This replacement or adjunct to conventional tactical seekers. The investigator will be required to assess the potential for arrays of magnetometers to detect, recognize and isolate tactical targets in clutter at various ranges out to a few kilometers. These arrays should be capable of eventual packaging in small seeker configurations. Consideration will be given to the need for gimbals, auxiliary sensors, strap down operation, accuracy, influence of the earth's magnetic field and the effects of simple countermeasures. If necessary the properties compatible with the requirements derived during the initial study of a test array or to testing of development magnetometers. Proposals must contain analysis indicating preliminary feasibility assessment. Performer and installation must have Secret clearance.

SB86-002 TITLE: Advanced Gun Propellants

DESCRIPTION: Current gun propellants are based on formulation containing primarily nitrocellulose, blended with various other ingredients that modify nitrocellulose physical ballistic properties. Despite the success of nitrocellulose based gun propellants two performance areas need improvement: very high muzzle velocities will require a combination of high propellant gas temperatures and very low molecular weight of the propellant gas. For nitrocellulose propellants temperature of 2700 degree K are command and propellant gun molecular weight of about 25; limiting velocities for those propellants are about 6500-7500 ft/sec. We are interested in new gas propellant formulations that have the potential of muzzle velocities of 7500-10000 ft/sec at temperatures less than 4000 degree K with propellant gas molecular weights below 19.

SB86-003 TITLE: Advanced Explosives and Energetic Binders

DESCRIPTION: Current very energetic explosives and propellants include materials such as RDX and HMX which have very high energy but which are also extremely sensitive. New techniques are needed for introducing nitro groups into aromatic N-heterocyclic compounds. Preparation of nitro aromatic N-heterocyclics is recognized by the explosive and propellant community as highly desirable. Techniques for the synthesis of the caged hexa-N are also desired.

Low modular weight polymers have the potential to impact a broad range of explosives and propellants. Polymer binds are used to modify all aspects of performance and properties of explosives and propellants. Synthesis techniques for new types of very low molecular polymers for use with very high energy oxidizers such as RDX, HMX, Nitro N-heterocyclics, and other very high energy compounds are desired.

SB86-004 TITLE: Novel Concepts for Electromagnetic Accelerators

DESCRIPTION: Electromagnetic launchers have possible applications to a variety of defense needs. Railgun accelerators have received the most attention but some work has been done on alternate accelerators: coilguns, mass driver, and induction accelerators (see IEEE Transactions on Magnetic, Vol. 20, No. 2 March 1984).

Ideas are being sought for novel accelerators capable of driving small masses (1 to 20 gm) to velocities in excess of 20 km/sec.

SB86-005 TITLE: High Power Density Pulsed Electro-Chemical Energy Sources

DESCRIPTION: Many military systems would benefit greatly from electro-chemical power sources that are well beyond the present state-of-the-art in power density and that have one or more other unique properties; e.g., the

ability to produce 1 to 100 millisecond pulses. This task seeks innovative concepts, which will make possible a substantial advance in the power density of fieldable electro-chemical pulsed power sources. Here an electro-chemical power source can mean a battery or a fuel cell; also, both primary and secondary power sources are of interest. Peak power densities in excess of 20kw/kg are required a fully packaged power source. While the task goal is stated in terms of power density (watts/kg), concepts which might lead to other unique attributes (watts/cm3, conformability, etc.) will be considered.

SB86-006 TITLE: High Power Density Components For Electromagnetic Launchers

DESCRIPTION: Electromagnetic launchers are being considered for a variety of missions including anti-aircraft, armor and ballistic missile defense. Innovative concepts are needed in a variety of technologies relating to the repetitive operation of such devices as practical weapon systems. High current opening switches and acceleration concepts that mitigate or eliminate opening switches are needed. High power density electrical power supplies and pulse forming networks are desired to minimize the total system weight. Techniques for reducing and rejecting the waste heat generated in switches, rails, inductors and other components are desired for both ground and space based systems. Materials and methods for reducing erosion and increasing life of rails and sliding electrical contacts would be valuable. Innovative concepts for applying electrical energy to achieving high projectile velocities with high efficiency are particularly sought.

SB86-007 TITLE: Application of Adaptive Neural Networks

DESCRIPTION: New approaches and concepts are sought to develop and apply novel computational methods associated with physiological models. Such methods might utilize models of human neurons and networks of neurons to deal with complex problems such as learning and planning. These networks of neuron models are often found to be adaptive to their environments, and respond to external changes by altering their input gains according to some functional relationship.

The goal is to apply these new techniques to problems associated with tactical air warfare avionics, such as trajectory determination, pattern recognition, and adaptive threat response. Adaptation of computational approaches to utilize new ideas and hardware and software developments in parallel computing architectures is anticipated.

SB86-008 TITLE: Small Unit Mission Electronic Equipment

DESCRIPTION: New approaches and concepts are sought to develop small, lightweight, waterproof, low probability of intercept and low probability of detection mission electronics equipment for small units. Concepts should be modular (allowing independent or collective operations) with each individual radio transmitter having a common power system and common connectors. The frequency spectrum of interest is low through extremely high frequency. Accommodations of various modems is desired as are built-in antenna matching units which optimize size and weight. A common data message input/output burst device is also desired.

SB86-009 TITLE: Advanced Technology Batteries for Small Units

DESCRIPTION: New approaches are sought to develop rechargeable and disposable batteries that provide greater energy density and are smaller, lighter, cheaper and safer than current batteries such as the BA-5590/U. It is desired that the battery power or variety of sources and optimize ampere hour capacity per gram of weight and battery life. Finally, the concept should allow for transport on all commercial and military aircraft.

SB86-010 TITLE: Advanced Technology

DESCRIPTION: The DoD has increasingly stringent materials requirements in order to achieve many of its future systems concepts. These advanced materials will need to be processed, utilizing revolutionary concepts for process

control which involved direct, in-situ, real time monitoring of the evolution of intrinsic features of the material such as microstructure, phase change, defect formation, etc. DARPA has interest in research aimed at such sensors for processes including in bulk crystal growth of especially gallium arsenide for critical steps in the production of advanced carbon-carbon composites. Proposals should address the rational concerning which aspects of the process are key to successful, reproducible manufacture of such materials and how the specific sensor research proposed addresses the need.

SB86-011 TITLE: Instrumentation for Semiconductor Material and Device Characterization

DESCRIPTION: Electrical characterization of devices often proves to be the most sensitive measurement for indicating problems in starting materials or processing techniques. Instrumentation is needed that can relate the electrical determinations to elemental impurities and/or stoichiometric variations. The instrumentation programs proposed in this area should focus on either GaAs, HgCdTe or electro-optic materials, and should clearly establish the methodology for relating the electrical or optical properties to the physical measurements.

SB86-012 TITLE: Military Applications of Conducting Polymers

DESCRIPTION: In the later 1970's, the materials field of conducting and semiconducting organic polymers was opened with discovery of the prototype materials, doped polyacetylene, (CH) x. In broad terms, these materials have conceptual applications as classical semiconductor device structures, lightweight wires, electro-magnetic shielding, transparent conducting coatings, batteries, and perhaps optical fibers. While the stability and other properties of (CH) x initially precluded "real-world" use of conducting (CH) x in these applications, subsequent development of other much more robust conducting polymers (as well as advances in (CH) x itself) suggest that these materials now deserve detailed considerations for applications to military systems and problems. This task seeks to identify and develop specific concepts for the application of conducting polymers in military systems. Proposals must elucidate clearly and concisely the potential advantages of using conducting polymer materials compared to any presently used material, and/or elucidate a unique system capability which will result. Polymers which exhibit electronic or ionic conduction are of interest. Proposals which comprise largely of research and characterization of potential new conducting polymer systems will not be considered in the task.

SB86-013 TITLE: Electro-Optic Techniques for VLSI Interconnect

DESCRIPTION: A major limitation to achieving significant speed increases in VLSI lies in the metallic interconnects. They are costly, not only from the charge transport standpoint, but also from capacitive loading effects. The Department of Defense, in pursuit of the fifth generation supercomputer, will be investigating alternatives to the VLSI metallic interconnects, especially the use of optical techniques to transport the information, either inter- or intrachip. Interests include such areas as source and detector integration optical switching elements, reconfigurable optical channels, and all-optical generalized cross-bar switching networks.

Guided channels may be considered for intrachip interconnects, but the advantages of unguided optical channels should play a major role in solving interchip and interprocessor communications. Once the electronic signals have been converted to optical signals, optical imaging and holography may be used to guide the optical beam to its destination which would likely be a photo-detector to another chip. One may go so far as to envision reprogrammable interconnects employing the optical phenomena of four-wave mixing. The bottom line in realizing opto-electronic interconnects is a need for research into nonlinear optics because it is the nonlinear aspect of optics that lies at the root of many of the desired operations – from integrated light sources, through optical switched and reconfigurable channels, to four-wave mixing. Consideration will be given to proposed studies into nonlinear optical materials, new device concepts, optical/electronic integration schemes, and interconnect architecture.

SB86-014 TITLE: Low Cost Mobile Robot

DESCRIPTION: Intelligence evolved in mobile creatures which had to deal with the complexity and variability of the real world. Resaerchers differ on whether initial conceptual research on intelligent systems should be performed in a simulated artificial environment, or in a real world setting; however, the proof of a concept in intelligent systems lies in whether or not that concept improves the system's performance in a real-world environment. In particular, a mobile robot offers an excellent platform for evaluating the perceptual and planning capabilities of an intelligent system.

We desire a low cost (%5k to $50k each in quantities of 100) multi-purpose mobile robot suitable for educational and laboratory use. Just as the proliferation of computer-based work stations has accelerated progress in computer science, so should the ready availability of a suitable mobile robot accelerate the progress in intelligent systems research. This study should trade off possible capabilities of the robot vs. cost and produce an effective design.

Modularity and interfaces are important considerations. Almost all users are expected to need an imaging visual sensor (e.g. TV camera). Many users will require some form of manipulator(s). Other sensors and effectors should be considered. Careful attention should be paid to the mode of mobility. Wheels or tank-tracks are possibilities, an air bearing would require a specially prepared environment and would therefore probably be too limiting, and legged locomotion is quite general, but may be too expensive. Some on-board local processing will no doubt be required, but users are expected to have substantial processing resources in their laboratories, on which their algorithms already run. Therefore a capable bi-directional tele-communications link will be required.

SB86-015 TITLE: Chemical Vulnerabilities of Armored Vehicles

DESCRIPTION: Proposals are desired that will assess the vulnerabilities of current and future armored vehicles to chemical warfare. The vulnerabilities may include windows, sensors, rubber and synthetic components, antennae and other communications equipment, lubricants and so on. The intent of such warfare would be to desiable or significantly reduce the fighting capability of armored vehicles for a significant period of time – hours to days. Issues of interest include the systems, subsystems and components of armored vehicles that are vulnerable to chemical warfare, the chemistry of such warfare, and the delivery systems appropriate for the chemistry and the target.

SB86-016 TITLE: Performance Evaluation of Artificial Intelligence Systems

DESCRIPTION: The field of artificial intelligence has advanced to the point where some exciting practical applications are possible. Most of those applications are expert systems, but there is growing work in natural language understanding, speech understanding, and vision or image understanding. Techniques are needed to evaluate the effectiveness and efficiency of such systems, both in order to compare competitive systems, and to measure improvements of such systems over periods of time. Some of those techniques may come from the field of psychological testing or, in the case of the expert systems, from software engineering techniques applicable to measuring programmer productivity. Proposals are desired that will explore and evaluate such methods and techniques.

SB86-017 TITLE: Algorithms and Multiprocessor Architectures

DESCRIPTION: A new generation of multiprocessor supercomputers is being developed that attains high speed by connecting many processors in a network, rather than through the use of ultra-high speed microelectronics. Efficient and effective algorithms for computation on such architectures are quite different than those developed for standard von Newmann computers. Proposals are requested for algorithms in a variety of areas including but not limited to harmonic analysis, linear programming, partial differential equations, computational geometry.

SB86-018 TITLE: Compact, High Average Power Accelerators

DESCRIPTION: Accelerating charged particles is a relatively recent scientific pursuit that had its beginning in the early 1930s. With the development of the Advanced Test Accelerator by DARPA at the Lawrence Livermore National Laboratory and the Radial Line Accelerator-II by the Air Force and Department of Energy at the Sandia National Laboratory in the early 1980s, the use of accelerators for possible defense applications are being investigated. Applications of electron microwaves, etc. are just beginning to appear.

Both potential defense applications and commercial applications of high average power electron beam acceptors would benefit from innovative ideas on the miniaturization, weight reduction and cost reduction of the accelerators. New developments in accelerator pulsed power drives and the beam handling technology suggest that large improvements can yet be made with minimal levels of effort. Innovative ideas are sought for concepts and designs which can operate at power per unit accelerator weights in excess of 10 Ks/Kg and with accelerating gradients exceeding 20 Mev/m. The offeror should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

SB86-019 TITLE: Diffractive Optics

DESCRIPTION: Diffraction gratings have been used extensively by the scientific community. The invention of lasers and its application in holography have spawned a number of new scientific, military and commercial applications. Recent developments in the calculation of resonant electromagnetic fields for deep gratings and the application of computer and VLSI technology to generate the high resolution, high accuracy patterns have created a new class of binary diffractive infrared optics, which are high quality (/100) and have high efficiency (95%). Workers at MIT Lincoln Laboratory have designed and tested various optical components including high-performance laser radar binary telescope and high-efficiency binary phase-grating beam combiner for combining multiple laser beams. It appears that the high quality and high efficiency binary optical components and subsystems can be obtained using low cost materials if some of the basic processes can be further improved.

Innovative ideas and designs are sought. These include the development of lithographic software using a polar or curvilinear coordinate system which are better matched for diffractive optics applications, development of laser beam writers which can provide low-cost, very fast lithographic pattern generators, useful for target acquisition, fire control subsystems, robotics, optical interconnect switching and product labeling as well as other innovative concepts to extend the binary optics technology to shorter, visible wavelengths and to dynamic situations. The offeror should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

SB86-020 TITLE: Technology for Electron Beam Guiding

DESCRIPTION: High intensity electron beams are finding wide application in the development of tactical and strategic technologies to meet DoD missions. Recent experimental results obtained with the Advanced Test Accelerator (ATA) demonstrate that pulsed (50 msec), high current (10 kiloamp) electron beams can be stably guided by a tenuous plasma column created in benzene gas by two photon ionization with a krypton fluoride laser. This powerful new technique relies on electrostatic focusing of the high energy electron beam by the positive space charge of the ion column which remains after the beam electrons have expelled the background plasma electrons. High current beam instabilities, which had previously limited electron beam currents to less than 5 kiloamps, are totally suppressed by this new technique. The laser guiding concept has substantially expanded DoD capability to generate high energy, high current electron beams.

This task is directed toward the development of new concepts and technologies for guiding high current electron beams in linear induction accelerators such as the ATA. Ideally these concepts would be compatible with beam repetition rates up to 30 kilohertz in burst mode operation (10-20 pulses per burst), efficient extraction of the electron beam from the accelerator and achievement of low beam emittance. The offeror should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

SB86-021 TITLE: Discharge Pumped CO2 Laser Technology

DESCRIPTION: Pulsed moderate power CO2 laser technology is supporting a broad spectrum of current DoD applications. Potential applications range from sensor negation on the tactical battlefield to laser radar for optical imaging and discrimination. During the past decade, substantial progress has been made in the development of gas discharge pumped CO2 laser technology. This research has demonstrated that the efficiency, volumetric scalability and pulse length achievable with these lasers depend critically on maintaining discharge stability at the pump power densities required for efficient power extraction. Innovative discharge pumping techniques have been developed to provide pump power densities consistent with high electrical and volumetric efficiency. Those methods include the electron beam sustained discharge, pulser-sustainer discharge and UV or X-ray preionized discharged, each of which ahs been tested successfully but all of which have limitations for DoD applications.

This task will develop alternate pulsed CO2 laser discharge technologies with the objective of increasing efficiency, increased repetition rate, pulse length and extracted energy per unit volume while reducing laser complexity, size and analysis, design and a limited demonstration.

SB86-022 TITLE: Applications of Distributed Computation

DESCRIPTION: Research on distributed computation has produced many interesting distributed software systems and concepts over the past few years. These include distributed data bases, distributed signal processing, distributed AI techniques, and distributed debugging. Applications of these and other similar concepts to selected military areas has already included areas such as distributed sensor nets and distributed communication networks. Other new applications of distributed computing are requested that have direct strategic or tactical defense applications. Proposals in this area should show clearly how distributed systems can improve military capabilities in the field. In each case, the essential computation as well as computational resources should be fully distributed and show a significant advantage over centralized approach. Applications may cover existing capabilities which can be carried out much more effectively using distributed computation or, preferably, entirely new capabilities not previously possible or practical. Examples that involve only trivial cases of distributed computing (e.g. distributed digitization of sensor data for relaying to a central site) or a single central model point are not desired.