STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSSINES INNOVATION RESEARCH PROGRAM
Submitting Proposals

Send Phase I proposals (one RED original and four copies of the full proposal, PLUS three copies of Appendices A and B only) by US mail to:

Strategic Defense Initiative Organization
ATTN: TNI/SBIR
Washington, D.C. 20301-7100

For Administrative Help Only: Call 800-937-3150

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. **WARNING: only person with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a pentagon entrance is not sufficient.** Receipt of proposals will be acknowledged only if the proposal includes a self-addressed stamp envelope and a form (like Reference) that needs only a signature by SDIO.

SDI is a DoD project to explore the feasibility of finding and disabling s ballistic missile in flight.

Topics on the following pages broadly state SDI's interest. SDI seeks innovative concepts on the cutting edge of technology that might enable a defense against a missile in flight. SDI seeks concepts for its need of lighter, faster, smarter more reliable components. The proposer need not know details of possible SDI systems. SDI will also consider highly innovative technology that does not clearly fit into any specific topic.

SDI SBIR seeks a demonstrable product that makes a leap in capability. SDI seeks to invest seed-capital, to supplement private capital, in a product with a future market potential (preferably commercial) and a measurable SDI benefit. SDI SBIR will not fund ordinary research or studies (including surveys, assessments, data collection, or systems studies). Nor will it further develop concepts already mature enough to compete for venture capital or government development funds.

Phase I will show the concept feasibility and the merit of a Phase II that will demonstrate a prototype or at least show proof-of-principle. The development must be appropriate for a small firm. Principal Investigators who are tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract. Any waiver must be requested explicitly with a justification showing a compelling national need. SDI expects to grant no waivers.

STRATEGIC DEFENSE INIATIVE ORGANIZATION (SDIO)
SMALL BUSSINESS INNOVATION RESEARCH TOPICS

SDIO91-001	Directed Energy Concepts
SDIO91-002	Kinetic Energy Weapons
SDIO91-003	Sensors
SDIO91-004	Nuclear Space Power
SDIO91-005	Non-Nuclear Space Power and Power Conditioning
SDIO91-006	Propulsion Logistics
SDIO91-007	Thermal Management
SDIO91-008	Survivability
SDIO91-009	Lethality
SDIO91-010	Computer Architecture, Algorithms, and Language
SDIO91-011	Optical Computing and Optical Signal Processing
SDIO91-012	Space Structures
SDIO91-013	Structural Materials
SDIO91-014	Electronic Materials
SDIO91-015	Superconductive Materials

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM

SDIO91-001 TITLE: Directed Energy Concepts

DESCRIPTION: Innovative applied research in the generation and propagation of directed energy plays an important role in developing an effective ballistic missile defense system. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, and free electron lasers. Hybrid approaches are also of interest. Interest in the concepts include the full range of embodiments, i.e., low mass spaced based ground-based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, acquisition, tracking and pointing, mirror technology, beam propagation through natural and disturbed environments, optics, and countermeasures.

SDIO91-002 TITLE: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons are candidates for strategic defense systems. Systems candidates presently include ground-based exoatmospheric re-entry vehicle interceptors (ERIS) and space-based interceptors (SBI), high endoatmospheric defense interceptors (HEDI) and hypervelocity guns (HVG) [electromagenetic (EM), electrothermal (ET), and hybrid systems]. Approaches are sought which extend, facilitate, or reduce the cost of the concepts. Elements of the system include the space-based carrier vehicles (CV) or ground-based launchers, divert motors/nozzles, smart projectile components, and endo/ exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: SBIR acquisition of booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C.G. Control algorithms, fast frame and U.V. seekers, acquisition and track; ERIS target discrimination, seeker operational environments, lethality/miss distance; HEDI aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-structural integrity, non-nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; HVG lifetime, firing rate, projectile guidance and control projectile launch survivability; and, common among all systems reliability; producibility, maintainability, and low cost/low mass.

SDIO91-003 TITLE: Sensors

DESCRIPTION: Sensors and their associated systems will function as the “eyes and ears” of a space based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets decoys and other penetration aids are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed. With the intended goal of producing either a specific product or process. Examples of some of the specific areas to be addressed are: cryogenic coolers (open and closed systems), superconducting focal place detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering , range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based SDI application (uv-sub-mm wave), new optics and optical materials. Entirely new approaches as well as approaches that expand and improve present concepts are sought.

SDIO91-004 TITLE: Nuclear Space Power

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements. Methods and processes are being considered for a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are if interest for unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW power for house keeping, tracking, etc. this category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include thermionic and Rankine cycles. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of Topic 91-007, innovative thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

SDIO91-005 TITLE: Non-Nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of topic SDIO91-004, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW to MW power for house keeping, tracking, etc. Specific topics include novel battery concepts, chemically driven systems for burst power, advanced solar collectors and converters, inductive and capacitive stores, space based MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainability and reliability of space power systems (e.g. insulation and cable) are sought.

SDIO91-006 TITLE: Propulsion and Logistics

DESCRIPTION: Strategic defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Traditionally, the cost of space transportation and the operation of the spacecraft have been major factors in the determining the life cycle costs of space-based assets. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g. extending storage time of cryogenic fluids reduction of contamination from effluent, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expandable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of the SP-100 reference mission and solar power demonstration missions incorporating arcject thrusters, SDI seeks 30 kw arcjet thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system and power conditioning unit). Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid) in 30-1000 g range.

SDIO91-007 TITLE: Thermal Management

DESCRIPTION: The high power levels for space stations must dissipate heat. Expected power levels required for SDI space platforms will stress state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems and space platforms payloads. Some space platforms will require years of storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under condition of zero-g, concept and devices for all types of space-based power cycles, nuclear and non-nuclear, and can satisfy these projected space platform requirements.

SDIO91-008 TITLE: Survivability

DESCRIPTION: The Strategic Defense System elements must survive determined attacks against the system, and the natural space environments (atomic oxygen, space radiation and micrometeorites/debris). Survivability technology is needed for threat sensing, creation of false aim points and passive hardening. Contributions are sought in analytic methods, computer simulation/modeling, materials development and processing, component hardware, systems, design and analysis.

Threat sensors enable the defense elements to detect nuclear, laser and radio frequency weapon attacks, and to respond appropriately. Sensors, which can characterize the threat according to direction of attack, and spectral characteristics are particularly noteworthy. Technologies to create false aim points are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF and pellet/debris environments is needed, in addition to hardening against the natural space environments. SDS elements have common mission critical subsystems. Sensor systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, R and pellet/debris in addition to the natural space environments. Materials and component designs which are intrinsically hard to these environments, and/or protective devices are needed. A key area is sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, and focal plane arrays/read out electronics) must survive the laser, nuclear and IR environments. Nuclear and laser hard baffle materials, and devices for protection against unknown or agile lasers and rejection of R energy are of particular interest. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and R radiation are needed. Processors capable of operating in unique nuclear environments presented by the strategic application (i.e. multiple burst environments) while retaining full functionality are essential.

SDIO91-009 TITLE: Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. Innovative ideas or concepts for measurement of radiation of particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off. New concepts to produce higher probability of kill-given-a-hit.

SDIO91-010 TITLE: Computer Architecture, Algorithms, and Language

DESCRIPTION: Strategic defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computers architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.
- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.
- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular system, for tasks (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.
- Language design to develop code optimized for highly parallel processed architectures.
- Testing techniques that will provide a high level of confidence in the successful operation of extremely large software systems.
- Computer network and communications security. R&D for trusted computer systems in accordance with DoD 5200.28.STD; integration of COMPUSEC with COMSEC (DoD 5200.5).
- Self –adaptive processing and simulation. Algorithms and architectures for advances decision making.

- Neurocomputing and Man-Machine Interface-rule-based AI neural networks combined for decision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.

SDIO91-011 TITLE: Optical Computing and Optical Signal Processing

DESCRIPTION: dense computing capability is sought in all architectural variation, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. In particular, non-linear optical materials advancements and new bistable optical device configurations are of interest.

SDIO91-012 TITLE: Space Structures

DESCRIPTION: The strategic mission places great demands upon the design of space structures to be used for their fabrication. The requirements include structures for prime power systems, antennas, tracking and pointing systems, solar collectors, and pressure vessels. All of these present individual challenges in terms of stiffness, impact resistance, high temperature capability, deployment, etc. Most of the anticipated situations depend on major improvements in material properties, and cost effectiveness. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Techniques for both passive and active control of the structural dynamic responses to environmental and operational excitations are needed. Methods are needed to predict the dynamic performance and stability characteristics of structures acting in concert with on-board distributed controllers for maneuvering, pointing, and vibration/noise suppression. There is also a need for novel, lightweight large optical structures that are compatible with the space environment, and for innovative optics/information processing techniques which maximize the imaging performance that can be achieved with imperfect, temporarily unstable structures.

SDIO91-013 TITLE: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 91-012 will depend on major improvements in material properties and cost effectiveness. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter.

Specific goals requiring advances techniques and processes include imparting oxidation, resistance and damage tolerance to composites, enhancing the static and dynamic toughness of ceramic composites, and creating fatigue resistant metal composites with order of magnitude improvements in passive vibrational damping. Methods are needed to minimize fiber-matrix reactions in composites exposed to high operating temperatures. Tribology innovative techniques and ideas are sought in areas such as solid and liquid lubricants, moving mechanical assemblies, low density alloys, and antiwear adhesives. Advances are sought in materials for optical systems, components, and radiation hardening. The following are sought: innovative manufacturing methods for producing high modules, fiber-reinforced glass, light metal (i.e. aluminum or magnesium), or thermoplastic matrix composites; innovative procedures for the production of consistent starting materials for advanced composites; novel instrumentation, sensors and software for online process monitoring and devaluation of high modulus, fiber-reinforced composites; novel instrumentation, sensors and software for online process monitoring and devaluation of high modulus , fiber-reinforced composites; novel approaches to modify surfaces to promote fiber/matrix adhesion in advanced composites; innovative surface modifications to promote fiber/matrix adhesion in advanced composites; novel instrumentation for telemetry of material properties and data from space; novel approaches for analytical modeling of generic space structures with experimental verification; new types of embedded active/passive sensors for structural control and real-time monitoring of structural behavior; and new methods for integrating instrumentation (i.e. embedded sensors) into advanced composite materials and structures. Proposals involving these as well as other space structure and material-related research and innovative technology topics are sought.

SDIO91-014 TITLE: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many strategic defense applications will require advances in electronics materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. among the many SDI electronic needs are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting path in poly ceramic systems, and sol-gel processing for packaging materials.

SDIO91-015 TITLE: Superconductive Materials

DESCRIPTION: Interest in these high temperature superconducting materials includes characterization, stabilization of new high-Tc phases, and development of novel fabrication techniques for both the thin-film and bulk materials,. Areas of application are also being stressed and include: novel, low-power infrared (IR) staring-array sensors, particularly those with monolithic focal plane pixel arrays and read-out electronics; high Tc superconductive materials for various electronic applications, e.g. Josephson junctions and SIS mixers; bulk materials for power transmission, conditioning, and storage; compact, high gradient accelerator cavities for novel particle beam and free-electron laser design concepts; magnetic shielding of critical components from EMP effects. Note that in the applications area interest area is not limited to only this new class of high Tc superconductors but attention is also given to the more mature low Tc materials as well, e.g. Niobium and Niobium Nitride.