DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

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

DARPA has identified technical topics to which small businesses may respond in the first fiscal year (FY) 00 solicitation (00.1). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical program managers and are directly linked to their core research and development programs.

Please note that **5 copies** of each proposal must be mailed or hand-carried. DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

- DARPA Phase I awards will be Firm Fixed Price contracts.

- Phase I proposals **shall not exceed $99,000**.

- DARPA Phase II proposals must be invited by the respective Phase I technical monitor (with the exception of Fast Track Phase II proposals – see Section 4.5 of this solicitation). DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately $375,000; the second 10-12 months of incremental funding should also be approximately $375,000. The entire Phase II effort should generally not exceed $750,000.

- It is expected that a majority of the Phase II contracts will be Cost Plus Fixed Fee.

Prior to receiving a contract award, the small business **MUST** be registered in the Centralized Contractor Registration (CCR) Program. You may obtain registration information by calling 1-800-334-3414 or internet: http://ccr.edi.disa.mil. The small business **MUST** also have a Commercial & Government Entity (CAGE) Code. This code is part of the CCR registration package. For information call 1-888-352-9333 (Press 3) or 1-888-227-2423 or internet: www.ccr.dlsc.dla.mil.

The responsibility for implementing DARPA's SBIR Program rests with the Administration and Small Business Directorate (ASBD). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/ASBD/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 526-4170
Home Page http://www.darpa.mil

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

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., "The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution" (refer to section 4.2 Evaluation Criteria - Phase I), twice the weight of the other two evaluation criteria. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may not fund any proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

- Cost proposals will be considered to be binding for 180 days from closing date of solicitation.
- For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information.
- Successful offerors will be expected to begin work no later than 28 days after contract award.
- For planning purposes, the contract award process is normally completed within 45 to 60 days from issuance of the selection notification letter to Phase I offerors.

The DOD SBIR Program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. **DARPA encourages Fast Track Applications between the 5th and 6th month of the Phase I effort. Technical dialogues with DARPA Program Managers are encouraged to ensure research continuity during the interim period and Phase II. If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will not exceed $40,000.**

To encourage the transition of SBIR research into DoD Systems, DARPA has implemented a Phase II Enhancement policy. Under this policy DARPA will provide a phase II company with additional phase II SBIR funding if the company can match the additional SBIR funds with non-SBIR funds from DoD core-mission funds or the private sector; or at the discretion of the DARPA Program Manager. DARPA will generally provide the additional Phase II funds by modifying the Phase II contract.

DARPA 2000 Phase I SBIR

Checklist

1) Proposal Format

a.	Cover Sheet (formerly referred to as Appendices A and B) **MUST** be submitted electronically (identify topic number)	______
b.	Identification and Significance of Problem or Opportunity	______
c.	Phase I Technical Objectives	______
d.	Phase I Work Plan	______
e.	Related Work	______
f.	Relationship with Future Research and/or Development	______
g.	Commercialization Strategy	______
h.	Key Personnel, Resumes	______
i.	Facilities/Equipment	______
j.	Consultants	______
k.	Prior, Current, or Pending Support	______
l.	Cost Proposal (see Reference A of this Solicitation)	______
m.	Company Commercialization Report (formerly referred to as Appendix E) **MUST** be registered electronically (register at http://www.dodsbir.net/submission; include signed hard copy along with proposal)	______

2) Bindings

a.	Staple proposals in upper left-hand corner.	______
b.	**Do not** use a cover.	______
c.	**Do not** use special bindings.	______

3) Page Limitation

a.	Total for each proposal is 25 pages inclusive of cost proposal and resumes.	______
b.	Beyond the 25 page limit do not send appendices, attachments and/or additional references.	______
c.	Company Commercialization Report (formerly referred to as Appendix E) is not included in the page count.	______

4) Submission Requirement for Each Proposal

a.	Original proposal, including signed Cover Sheet (formerly referred to as Appendix A)	______
b.	Four photocopies of original proposal, including signed Cover Sheet and Company Commercialization Report (formerly referred to as Appendices A, B and E)	______

INDEX OF DARPA FY00.1 TOPICS

DARPA SB001-027	Automatic Terrain Characterization and Feature Identification in FOPEN SAR Imagery
DARPA SB001-028	Acousto-Optic Spectra-Polarimetric Imaging
DARPA SB001-029	High Power Fiber Lasers
DARPA SB001-030	Advanced Gating Techniques for Planar, High power Non-Linear, Semiconductors in Advanced Mobile Power Conditioning Applications
DARPA SB001-031	SiC Inverter
DARPA SB001-032	Group Target Tracking
DARPA SB001-033	Component Technologies for Closed-Loop Adaptive Flow Control

SUBJECT/WORD INDEX TO THE DARPA FY00.1 TOPICS

Subject/Keyword Topic Number

DARPA 00.1 TOPIC DESCRIPTIONS

SB001-001 TITLE: Conductive Coating with Mid-Infrared Transparency

KEY TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

OBJECTIVE: The objective of this task is to develop a low sheet resistance coating with transparency in the mid-infrared spectral region.

DESCRIPTION: Transparent, conductive coatings are used in numerous optical systems for ElectroMagnetic Interference/Radio-Frequency Interference (EMI/RFI) shielding, static elimination, electrodes on flat panel displays, and light emitting polymer devices. They are also used in applications where fine metal grids would impair optical performance, such as antennas embedded in windshields. The most widely used transparent, conductive coating is indium tin oxide (ITO). ITO is a large band gap semiconductor, which has good transparency in the visible region and near-infrared, along with modest sheet resistivities of ~5 ohms/square. However, the transmittance of ITO and related compounds degrades to unacceptable levels for wavelengths longer than 1.3 microns. Low sheet resistance, transparent conductors are needed for optical systems operating in the wavelength range of 3 to 5 microns. In addition to the standard applications of transparent, conductive coatings for EMI/RFI shielding, etc., mid-infrared coatings are needed in displays for the testing of missile seekers and in active camouflage devices. The goal of this project is to develop conductive films with sheet resistivities of ~1 ohm/square and having a transparency band in the mid-infrared spectral region. Low sheet resistivities of 1 ohm/sq are required for effective shielding and allow for the fabrication of large area displays. The transmittance of the coating should be >70% over a wavelength band of >100 nm. The center wavelength of the transmission window shall be adjustable over the range of 3 to 5 microns by modification of the growth or processing parameters. The film growth should not require excessive substrate temperatures and fabrication procedures should be compatible with standard, thin film processing techniques. The fabrication costs of the coatings should be comparable to ITO coatings.

PHASE I: Demonstrate the fundamental technologies required to produce coatings having low sheet resistivities and high transparency in the mid-infrared.

PHASE II: Demonstrate compatibility with processes and materials used in mid-infrared optical systems. Perform reliability and lifetime measurements on the conductive coatings.

PHASE III DUAL USE APPLICATIONS: EMI/RFI shielding and static elimination in remote sensing systems, air pollution instrumentation, gas analyzers, and mid-infrared astronomy.

KEYWORDS: Transparent Conductors, Thin films, Optical Coatings.

REFERENCES: H.L. Hartnagel, A.L. Dawar, A.K. Jain, and C. Jagadish, "Semiconducting, Transparent, Thin Films," Institute of Physics Publishing, Bristol, U.K., 1995.

SB001-002 TITLE: MEMS-Based Switches for RF Missile Seeker Applications

KEY TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace, Weapons

OBJECTIVE: Reduce insertion loss in the on state and increase isolation in the off state switches for RF missile seekers using MEMS technology while maintaining power handling capability of current solid state switches.

DESCRIPTION: Micro electromechanical system (MEMS) technology is rapidly providing solutions to a variety of commercial and military applications in terms of size, performance, and cost. RF MEMS technology has been funded to develop digital receiver and transmitter technology. However, these efforts have focused on communication frequency bands significantly less than that used for RF missile seeker applications. Development of RF MEMS technology of interest to RF missile seekers has been limited. Several key Army missile systems have been identified as potential insertion opportunities for RF MEMS. These systems and their associated frequency bands are: LONGBOW (Ka – 26-40 GHz), BAT P3I (W – 94.5 GHz), and THAAD or PAC-3 missiles (X – 8-12 GHz). The basic missile radar system consists of an exciter to generate a stable waveform to produce a local oscillator signal, a transmitter to amplify or frequency tune the signal to be transmitted, a duplexer that switches the antenna and resulting radar system between transmit and receive modes, an RF receiver to receive the radar return signal and down convert to the first intermediate frequency (IF), an IF receiver to down convert the radar return to baseband before sending the information or video signal for processing. Each of these components contains some form of RF switches. Therefore, the basic building block to prove viability of MEMS technology for RF missile seeker frequencies is switches.

PHASE I: Design and demonstrate proof of principle of a MEMS-based RF switch (single pole, single throw) at X, Ka, or W band. If only one band is selected for demonstration, a path or plan of development for switches at the other bands should also be provided. The RF switch should have a switching speed of 20 ns rise time (10 to 90%) and 150 ns fall time (90 to 10%). The maximum power handling capability of the switch should be 0.5 Watts continuous wave (CW) and 10 Watts peak. The switch(es) shall be capable of operating between temperatures from -55C to 150C. The switch at X-band should have a bandwidth of 8 to 12 GHz, a max insertion loss of 1.3 dB, and minimum isolation of 36 dB. The switch at Ka should have a bandwidth of 26.5 to 40 GHz, a max insertion loss of 1.5 dB, and minimum isolation of 30 dB. The switch at W-band should have a bandwidth of 90 to 100 GHz, a max insertion loss of 2.0 dB, and minimum isolation of 20 dB. Specifications not directly outlined should be commensurate with current technology. Table 1 outlines the electrical specifications. Any available prototype(s) should be delivered to the Government for further testing at the end of Phase I.

Bandwidth, GHz	8 – 12	26.5 – 40	90 – 100
Insertion Loss, dB(max)	1.3	1.5	2.0
Isolation, dB (min)	36	30	20
Switching Speed, ns			
Rise Time, 10 to 90%	20	20	20
Fall Time, 90 to 10%	150	150	150
Power Handling, CW/peak, W(max)	0.5/10	0.5/10	0.5/10

Table 1. Electrical Specifications

PHASE II: Validate design by fabricating fully-packaged prototype(s) of MEMS-based RF switches suitable for RF missile seeker applications, and with performance specifications at or exceeding those named above – teaming with government, industry, or academia foundries as necessary. Physical dimensions should not exceed 0.75 x 0.75 mm. Confirm performance through laboratory testing with interested government users for technology insertion.

PHASE III DUAL USE APPLICATIONS: Switches of the suggested type would have wide applications in both military systems (dual band seeker technology) and civilian products (satellites, antennas, communication systems).

KEYWORDS: MicroElectroMechanical Systems, MEMS, Radar, RF Switch, Missile Guidance.

REFERENCES:
1. Digital Receiver Technology Program, DARPA MTO, Program Manager: Dr. James Murphy, http://www.darpa.mil/ETO/ADC/index.html.
2. Raytheon Systems, UltraComm Program, DARPA ATO, Program Manager: Mr Richard Ridgley.
3. Elliot R. Brown, “RF MEMS Switches for Reconfigurable Integrated Circuits,” IEEE Trans. Microwave Theory and Techniques 46 (11), 1868-1880 (1998).
4. Clark T.-C. Nguyen, et al., “Micromachined Devices for Wireless Communications,” Proceedings of the IEEE 86 (8), 1756-1768 (1998).
5. Y. C. Lee, et al., “RF MEMS Device, Packaging, and System,” http://www.Colorado.EDU/engineering/MEMS/ppt/rf.review

SB001-003 TITLE: Mortar or Rifle Launched, Low Cost, Miniature Ballistic and Glided Flight Surveillance Sensor Systems

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace, Weapons

OBJECTIVE: Develop and demonstrate low cost, miniature, surveillance sensor systems that are ground deployed from either a mortar launcher or a rifle and are retrievable.

DESCRIPTION: Small, highly mobile, dispersed forces need an organic capability to deploy and retrieve over-the-horizon capable (greater than 30 kilometers) miniature sensor systems to provide near real-time threat and terrain related information. Specifically, research and development leading to the design and demonstration of novel, advanced, rifle and mortar launched and retrievable surveillance sensor systems for the over-the-horizon detection, localization, and classification of ground, and shallow water time critical targets are required. Efforts may address individual miniature system components, such as advanced propulsion systems or sensor systems, as payloads for these ballistic and glided flight vehicles, however concepts for complete mortar and rifle launched systems, are preferable. The use of conformal and deployable wings and control surfaces is required to insure compact stowability and ballistic tube launching of these sensor systems. Parameters of interest that will be utilized to evaluate proposed concepts are projected cost, size, weight, flight duration, maximum altitude, effective trajectory path length from launch to return for recovery, stowage capability, reconfigurability through modular design, power consumption, covert operations, and sensor performance. Aggregate metrics, such as dollars per kilometer squared surveillance coverage, will be utilized to compare proposed concepts.

PHASE I: Concept description and initial design of the miniature, integrated sensor and vehicle system, with an imaging subsystem payload configuration, with clear description and quantification of key predicted performance parameters. A sensitivity analysis that indicates the predicted performance of alternate proposed system configurations, including identification of highest risk aspects of the proposed design, is also required. Risk mitigation demonstrations and/or simulations of key high-risk aspects of the proposed design, to demonstrate proof of concept, is also required.

PHASE II: Final design and demonstration of the proposed miniature, integrated sensor and vehicle system, with post-demonstration analysis sufficient to demonstrate key performance elements for the proposed system. Complete design and demonstration documentation must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of low cost, high performance, modular, miniature surveillance sensor systems will expand the commercial markets for industrial and area security systems, agriculture, forestry, and industrial process monitoring systems and disaster and environmental monitoring systems. Increased performance, component modularity for optimum domain specific tailoring of sensor and surveillance vehicle configurations and the dramatic reduction in size, weight and cost of these sensor systems will increase the range of potential applications for these products. This system could be used for military war fighting applications, overseas peacekeeping operations or enhancing security of the US industrial infrastructure.

KEYWORDS: Projectiles, Sensor Systems, Air Vehicles, Environmental Sensors, Chemical Sensors, Imaging Sensors, Ballistic and Controlled Flight Air Delivery Systems, Low Power Electronics.

SB001-004 TITLE: Computationally Efficient Change Detection and Classification Algorithms for Imaging Systems Using Real-Time Target, Terrain and Urban Feature Data

KEY TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace

OBJECTIVE: Development of innovative, computationally efficient feature recognition and change detection algorithms for imaging systems capable of generating, in real-time, 2D and 3D models of terrain, urban, and target features.

DESCRIPTION: The requirement for sophisticated and comprehensive battlefield terrain, urban, and target feature information will continue to increase as combat operations requiring rapid force projection, high mobility of small dispersed units, and precision strike utilizing indirect fire assets, place a growing emphasis on unattended or minimally attended sensor systems. The effective use and control of terrain, urban, and target features are critical to detect, classify, and prosecute targets in land combat scenarios. A requirement exists for software, that transforms sensed 2D imagery of terrain, urban, and target features into scalable 3D model representations, in real-time, and then applies innovative, computationally efficient change detection algorithms to detect and classify targets of interest. An imaging based system, with dynamic terrain, urban, and target feature models and real-time change detection algorithms, will provide a significant force-multiplier affecting mission planning, systems performance, and overall unit effectiveness. Four different types of terrain, urban, and target feature information are required: (1) topography, (2) natural features and man-made structural objects in urban environments, (3) stationary and moving personnel and vehicles and (4) short-term battlefield surface conditions and dynamics. Dynamic 3-D terrain, 3-D feature models and efficient change detection algorithms are the enabling technologies for intelligent, imagery based sensor systems for use with arrayed, unattended ground sensors and autonomous mobile weapon systems. These technologies will also contribute to a significantly improved training capability by enabling realistic simulations of planned and already executed tactical operations.

PHASE I: Concept description, including the identification of key underlying technology and scientific issues, and an initial design of the software with clear description of algorithms, models, approach to parallelism, and limits of scalability. Quantification of key predicted performance parameters and a sensitivity analysis that indicates the predicted performance of alternate proposed software configurations, including identification of highest risk aspects of the proposed design, are also required. Risk mitigation demonstrations and/or simulations of key high-risk aspects of the proposed design, to demonstrate proof of concept, is also required.

PHASE II: Final design and demonstration of the proposed software with analysis sufficient to demonstrate proof of performance. Complete design and demonstration documentation must be delivered. Early emphasis during this phase will be on the generation of research and development tools for the processing, analysis, modeling, visualization, and simulation of detailed terrain, urban, and target feature information.

PHASE III DUAL USE APPLICATIONS: The development of these technologies will expand the commercial markets for intelligent sensor systems. These systems, with an ability to acquire, analyze, portray, and utilize superior terrain and urban feature information during the planning, preparation, and execution of complex and life threatening operations, will significantly improve the probability of operational success at minimum human and material cost. The improved capability to manipulate and evaluate information about terrain and features will facilitate enhanced planning and tactical decision making for applications related to global change and environmental studies. These technologies will also facilitate the development of new and improved techniques and software tools for virtual prototyping which will improve a system developer's ability to rigorously appraise functional designs thereby providing a significant cost saving in whatever application this technology is applied. The overall commercial impact of this intelligent sensor-related research effort will be significant. This system could be used for military war fighting applications, overseas peacekeeping operations or enhancing security of the US industrial infrastructure.

KEYWORDS: Sensors, Imaging Sensors, Terrain and Feature Modeling, Change Detection Algorithms, High Performance Computing, Computer Aided Design, Electronic System Design, Parallel Algorithms.

SB001-005 TITLE: Low Cost, Miniature RF MASINT Unattended Sensor Systems

KEY TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace, Weapons

OBJECTIVE: Develop and demonstrate novel concepts for detecting, localizing and classifying targets with arrays of low cost, miniature, internetted Radio Frequency Measurement and Signature Intelligence (RF MASINT) unattended ground and littoral sensor systems. Innovative solutions are sought for the short range, real time RF MASINT sensing problem using miniature local assets (vice theater or national assets) for the gathering of signal features from RF emitting sources, including vehicles, ballistic munitions, and surface and underground facilities.

DESCRIPTION: Research and development leading to the design and demonstration of novel, advanced RF MASINT unattended sensor systems for the detection, localization, and classification of air, ground, and waterborne time critical RF emitting targets are required. Efforts may address individual miniature RF MASINT sensor systems, however multi-sensor systems, with local signal processing, data fusion and an internetted communications capability are of primary interest. Low power, autonomous wake-up and commanded wake-up capabilities for these unattended systems are required. Efforts of interest also include low power, extended life, high resolution sensors, efficient real-time feature based classifiers, and environmental models for real-time transformation of sparse sensed data to predictions of area weather and propagation related parameters. Also of interest are decision aids to enable optimum configuration and processing of data from RF sensor arrays, and technologies to precision air deliver individual and arrays of unattended sensor systems from either tactical aircraft, unmanned air vehicles, mortars, and artillery shells, including packaging of these sensor systems in submunition sized configurations compatible with area denial missile systems such as the Multiple-Launch Rocket System (MLRS) and Army Tactical Missile System (ATACMS). Parameters of interest that will be utilized to evaluate proposed RF MASINT sensor concepts are projected cost, size, weight, reconfigurability through modular design, power consumption, covert operations, and detection, localization and classification performance. Aggregate metrics, such as dollars per kilometer squared detection coverage-hours of life without battery change, will be utilized to compare proposed concepts. Parameters of interest that will be utilized to evaluate proposed aircraft and unmanned air vehicle delivery system concepts are projected cost, size, weight, stowage capability, altitude and delivery range capability, precision of delivery circular error probable (CEP), and for earth penetrating concepts, the capability to penetrate in varying soil conditions while still maintaining communications and in-situ RF MASINT sensing capability after delivery.

PHASE I: Concept description and initial design of RF MASINT sensor related system with clear description and quantification of key predicted performance parameters. A sensitivity analysis that indicates the predicted performance of alternate proposed system configurations, including identification of highest risk aspects of the proposed design, is also required. Risk mitigation demonstrations and/or simulations of key high-risk aspects of the proposed design, to demonstrate proof of concept, is also required.

PHASE II: Final design and demonstration of the proposed sensor related system, with post-demonstration analysis sufficient to demonstrate proof of performance for the proposed system. Complete design and demonstration documentation must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of low cost, high performance, modular, miniature RF MASINT sensor and related sensor delivery systems will expand the commercial markets for home and industrial security systems, industrial process monitoring systems and environmental monitoring systems. Increased performance, component modularity for optimum domain specific tailoring of sensor configurations and the dramatic reduction in size, weight and cost of these sensor systems will increase the range of potential applications for these products. This system could be used for military war fighting applications, overseas peacekeeping operations or enhancing security of the US industrial infrastructure.

KEYWORDS: Radio Frequency, Antennas, MASINT, Earth Penetration Systems, Terabrakes, Ballistic and Controlled Flight Air Delivery Systems, Real-Time Signal Processing Algorithms, Feature Based Classifiers, Data Fusion Algorithms, Low Power Electronics, Wireless Communications, Low Probability of Detection and Intercept Communications.

SB001-006 TITLE: Distributed Sensor Location Algorithms

KEY TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace, Weapons

OBJECTIVE: Design and test algorithms to localize distributed air or underwater sensors that are used to detect, track and localize acoustic targets. The method of target or field interrogation can be either active or passive.

DESCRIPTION: Many distributed surveillance or warning systems "drop" individual sensors which have to be localized precisely later to perform spatially coherent or incoherent operations. Examples are air acoustic sensors for Counter Sniper Operations, Antisubmarine Warfare (ASW) applications, etc. To attach a Global Positioning System (GPS) to each sensor is an expensive solution. By super-triangulation using intentional or naturally occurring transmissions one can obtain localization information "through the system," without mode changes. For example, it is possible to localize K sensors with N or more shots as long as N > 3K/(K-4). End-to-end algorithms are sought and a quantitative discussion of sensitivities to near-singular geometries.

PHASE I: Define the systems for which the algorithm would be applicable and show the expected performance by computer simulation. Develop a systems design and indicate what technical issues to expect, such as multipath effects, shockwave versus muzzleblast, singular geometries, etc.

PHASE II: Develop a simplified or modify an existing government-furnished equipment (GFE) system and conduct testing in a realistic environment. Quantify the measured performance.

PHASE III DUAL USE APPLICATIONS: Military use applications are, in air, sniper or artillery detection and localization; underwater, submarine or torpedo detection and localization with non-fixed sensors. A commercial application of the method of localizing distributed sensors is for Systems for Urban Gunshot Detection and localization, as deployed by the police in some cities.

KEYWORDS: Counter-Sniper, Distributed Sensors, Random Array, Dynamic Localization.

SB001-007 TITLE: Autonomous Clandestine Precise Deployment of Communications/Sensor Packages

KEY TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Sensors/Electronics/Battlespace

OBJECTIVE: Develop innovative technology for the delivery of small packages into hostile territory. The packages, with 1 kg to 10 kg mass, must be placed on high ground such as on treetops and building tops and this must be done without being detected by the enemy. The technology desired is a vehicle with an integrated vision system and flight management system that will maneuver to the most advantageous position given the constraints of the vehicle's maneuverability and power source.

DESCRIPTION: Future military concepts employ unattended sensors and communications devices that are employed in the enemy's area of operation. The emplacement of such devices is very challenging due to many factors. First they must be placed to provide maximum line of sight or viewing conditions. Because the details of terrain and forestation may not be known, the deployment system must have the ability to autonomously search and find the best position for placement such as on the tallest tree or building. The other major factor is that the deployment process must be clandestine. DARPA envisions that the delivery system will be in the form of an air vehicle but land and sea vehicles may be utilized as well. The enabling technology is believed to consist of a stealthy vehicle and a tightly coupled flight management capability and automatic scene understanding system to drive the vehicle to the best high spot. If an air vehicle is used, because of atmospheric variations (winds and thermals) and flight control boundaries, the air vehicle must continuously search for the best remaining high spots (i.e., the options are reduced with time in flight). During flight or movement, multiple imaging sensor viewpoints are needed to develop/refine the understanding of the scene. That is, multiple viewpoints may need to be registered against the scene to create synthetic stereo image pairs to get a three dimensional model. Any imaging sensor maneuvers made to acquire different image viewpoints will limit the future spots that can be reached because of factors such as power supply use, loss of altitude and so forth. Consequently, scene understanding accuracy (e.g., height estimates) is a tradeoff against the gain in reaching a better landing spot. The design options that should be considered include:

- Powered/un-powered vehicles
- Controls: aero surfaces, jets, parafoil, tracks multiple legs, …
- Sensor: ladar, visible band EO synthetic stereo, combinations, …
- De-acceleration/transition: sticky webs, breaking jets, …
- Algorithms: flight management, imagery object recognition, scene understanding, …

PHASE I: The first phase should identify alternative solutions and conduct enough analysis to recommend one or more options for further investigation.

PHASE II: In the second phase, prototypes for one or several concepts will be constructed and demonstrated. DARPA will provide test payloads and a test range to conduct flight tests and demonstrations.

PHASE III DUAL USE APPLICATIONS: The ability to precisely deploy sensor and communications packages in hostile areas has direct application to police and civil actions, counter-terrorists actions, forest fire containment, and natural and unnatural disaster response. The clandestine mode is of utility to police and federal law enforcement authorities.

KEYWORDS: Autonomous Air Vehicles, Sensor Deployment

SB001-008 TITLE: Miniature Cryoelectronic Receivers

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Develop a miniature cryogenic receiver "front-end" for sub-scale ultra-sensitive receivers, operating as battlefield sensors.

DESCRIPTION It is well-known that receivers, even those operating within a limited bandwidth, should not be designed with a front-end filter, since that usually is the principal contributor to an unacceptable system noise figure. The exception to this rule is a high-temperature superconducting (HTS) filter; its combination of low insertion loss and sharp "skirts" provides an exceptionally low system noise floor and suppresses interference significantly. It is of great interest to reduce the size and power requirements (principally due to cryocooler operation) of present front-end preselector cryogenic modules, which consist of HTS filters and low-noise amplifiers (LNA) held at 80K temperature. This reduction can be achieved by addressing the principal issues of thermal isolation and small cryocooler development. The following goals are given: 0.25 Watt cooling lift at 80K for the cryocooler, and overall cryo-module weight of 2 pounds (each a factor of 10 below present standards). The attainment of such a small, cold front-end, when mated to digitization and processing chips, will make possible a new class of miniature portable receivers with unsurpassed sensitivity and interference rejection.

PHASE I: Design a miniature cryogenic "front-end" for a specific receiver function, containing an HTS filter and LNA combination, specifying the means of achieving thermal isolation while maintaining input/output leads for RF signals and power. At this stage, available cryocoolers may be indicated for use, but a prescription given for future changes.

PHASE II: Fabricate and demonstrate the performance of the miniature cryogenic receiver front-end.

PHASE III DUAL USE APPLICATIONS: The availability of such miniature ultra-sensitive receivers, which perform a kind of spectral excision, will apply to a broad range of military systems and commercial markets. Applications such as COMINT, SIGINT, SAR, …., are currently being investigated; commercially, these sensors will be important immediately in cellular communication and SATCOM.

KEYWORDS: Cryogenics, Cryoelectronics, Receivers, Superconductors.

REFERENCES: Patten, F. W., DARPA Program in Cryoelectronics, 1999 International Workshop on Superconductivity, Kauai, HI, USA.

SB001-009 TITLE: Self-Decontaminating Materials

KEY TECHNOLOGY AREAS: Chemical/Biological Defense

OBJECTIVE: Develop safe, efficient and cost effective self-decontaminating materials for neutralizing chemical and biological threat agents from personnel, electronic equipment, exterior and interior spaces of aircraft, ships, land vehicles, and buildings.

DESCRIPTION: Current chemical and biological (CB) decontamination procedures tend to be agent specific, corrosive, damaging to sensitive electronics, and usually require subsequent clean up. They create a logistics burden and do little to improve operational readiness after a CB attack. Innovative approaches are needed for the development of materials, which are self-decontaminating with respect to chemical agents, toxins, spores, bacteria, and viruses. Materials or coatings that emulate processes for neutralization of CB agents (i.e.: enzyme solutions/foams, metal and/or oxide catalysts, emulsions, or oxidative chemistries) may be explored. Example approaches include materials that can entrap and internally neutralize the agent or that become catalytically active in response to contact with an agent. A detailed understanding of CB agent chemistry (biochemistry) should be utilized to develop material compositions and microstructures suitable for neutralization of harmful agents. Greater interest will be shown to those approaches, which have the potential for the broadest range of utility.

PHASE I: Demonstration of conceptual feasibility for a self-decontaminating material/coating.

PHASE II: Rigorous analysis and laboratory demonstration of surface self-decontamination using suitable surrogates.

PHASE III DUAL USE APPLICATIONS: Development of self-decontaminating materials for CB countermeasures will have commercial applications in the food processing industry and in hospitals.

KEYWORDS: Chemical and Biological Agents, CB, Catalysts, Antimicrobial, Germicidal.

SB001-010 TITLE: Printed Optics

KEY TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop the machine capability to fabricate gradient index of refraction lenses via direct deposition with positional control of composition.

DESCRIPTION: Gradient Index of Refraction lenses (GRIN) are commonly fabricated by chemical diffusion into cylinders (radial GRIN), or plates (axial GRIN) as a means of developing a specific refractive index profile. The limitation of this process is a restriction to compositions with a fast diffusing specie, and to small size scale lenses since diffusion times scale with the square of the diffusion distance. An added disadvantage of diffusion processing is the composition dependency of diffusion constants, which distorts the desired composition profile. All of the limitations of the current manufacturing process for GRIN lenses may be addressed if composition profiles are printed using the three dimensional equivalent of a color printer. The printing of mosaic lenses becomes straightforward. Axial and radial composition profiles can be printed in the same lenses for achromatic lenses. Lenses with non-uniform magnification (fish eye) can be printed. And compositions with high transmission in the infrared, but without sufficient transport coefficients to be fabricated by diffusion processing would be possible with printed optics. Printed optics also has the potential to be manufactured at much lower cost than geometric lenses since no lens specific tooling is required and all optical surfaces are polished flat. Success in this project will depend on the integration of machine design and control for three dimensional deposition of composition; optical expertise in the design of GRIN lenses; and, materials expertise to produce optically transparent materials with virtually no porosity and smooth composition profiles at size scales small relative to the wavelengths of interest.

PHASE I: Design a machine capable of manufacturing Printed Optic lenses greater than five inches in diameter directly from CAD (computer aided design) files without lens specific tooling. Develop the materials processing technology to produce optical quality lens materials, which are compatible with the designed machine.

PHASE II: Build the machine designed in Phase I. Demonstrate the fabrication of five-inch diameter gradient index of refraction lenses. Characterize the optical quality of the lens.

PHASE III DUAL USE APPLICATIONS: Because of its simplicity and low cost potential, printed optics has the potential to replace geometric optics. Just-in-time manufacturing will replace assembly of catalogue optical elements. Applications include missile seekers and proximity detection systems for munitions, photographic lenses, binoculars, telescopes, and night vision systems.

KEYWORDS: Gradient Index of Refraction Optics, Solid Freeform Manufacturing, Rapid Prototyping, Tool-Less Manufacturing.

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SB001-011 TITLE: Comparative Gene Sequence/Expression Analysis of Pathogenic and Non-Pathogenic Micro-Organisms

KEY TECHNOLOGY AREAS: Chemical/Biological Defense

OBJECTIVE: Identify gene sequence “targets” that permit development of sensitive and specific (low false alarm) rapid-detection assays to distinguish biological warfare (BW) threat pathogens from ubiquitous, non-pathogenic, near-neighbors, surrogates, and obscurants in complex and unpredictable environments. Development of such suitable genetic markers and associated high throughput genomic technologies may also contribute to the development of approaches for the treatment of unconventional pathogens.

DESCRIPTION: This solicitation seeks to exploit high throughput (production) sequencing/gene expression technologies to: 1) distinguish between BW agents and their phylogenetic non-pathogenic nearest neighbors and 2) develop innovative technologies/methodologies for sequence annotation that improve our understanding of pathogenesis. The candidate pathogens are to be selected exclusively from among the relatively short list of bacteria, viruses and rickettsia identified in reference 2. Multiple awards are anticipated, with each individual award focusing on a narrow range of pathogens. To avoid unnecessary duplication of efforts, each offering team is asked to identify 4-5 pathogens of potential interest (and their corresponding non-pathogenic nearest neighbors) from which the sponsor can then down-select prior to the Phase 1 award.

PHASE I: Establish genomic libraries for target BW pathogen(s) and appropriate nearest neighbor(s); initiate sequence analysis.

PHASE II: Complete sequence analysis and annotation of BW pathogen(s); demonstrate methodology for distinguishing between target pathogen(s) and nearest neighbor(s).

PHASE III DUAL USE APPLICATIONS: Enhanced capability for diagnosis and treatment of broad range of infectious diseases.

KEYWORDS: Pathogens, Gene Sequencing, Annotation

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SB001-012 TITLE: Improving Recall for Automatic Extraction Systems

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective is to improve the recall (percentage of relevant domain facts extracted) of domain independent natural language text extraction systems.

DESCRIPTION: Domain-independent information extraction systems are information extraction systems that perform shallow, broad extraction. The major advantage of these systems is that no customization is required to apply them to a new domain. These systems have been developed and used for automatically populating knowledge bases. While these systems are very accurate (i.e. their precision is very high), they do not have comparable coverage (i.e. their recall is not as high). This SBIR is looking for proposals to develop the next generation of domain-independent information extraction systems. These systems should be capable of performing shallow, broad extraction with both high precision and high recall.

PHASE I: Recall enhancing algorithms defined and implemented; recall and precision performance validated experimentally.

PHASE II: Embed the recall-improving algorithms in a domain independent text extraction system. Test the system on a large corpus of free text documents to update a large knowledge base. Provide complete documentation of test results.

PHASE III DUAL USE APPLICATIONS: Many military, law enforcement and commercial knowledge bases and data bases are manually maintained because of insufficient recall performance. Timelines and workloads will be greatly reduced through automatic extraction that is both high precision and high recall. Improved extraction performance will greatly extend the market for domain independent extraction systems in support of link analysis, event recognition and question answering.

KEYWORDS: Text Extraction, Natural Language Processing, Automatic Data Base Update, Question Answering.

SB001-013 TITLE: Intelligent Adaptive Software Construction

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Experimentally develop and test a revolutionary approach to using Artificial Intelligence for software development and adaptation..

DESCRIPTION: This Program will experimentally develop and test a revolutionary approach to software development and adaptation. The approach, which combines analogic reasoning capabilities with planning technology, can provide a new approach to system synthesis and analysis. While the Program is defined in terms of software design and evolution, the same approach should hold for hardware (or combined hardware/software) systems, engagement planning (where the components are actions that may be taken to accomplish an objective under stated constraints), production planning, etc. Software development/evolution (which is a design, rather than production, activity) may be conducted by recognizing units at various levels of granularity (cliches, patterns, modules, packages, statements, expressions,...) that need to be connected together to perform the desired function. To go from Point A (e.g., radar signal received) to Point B (e.g., radar track displayed), a designer may "connect the dots" of cliches at the next lower level (e.g., radar signal transformed to x,y,z coordinates; point matched with existing tracks; tracks in current window displayed,...). This can be viewed as a route planning problem (with the added complications that dots are described in varying dimensionality, some dots may be missing -- requiring that components at the next lower level be connected to form the dot;....). The recognition of which components (dots) play which role(s) is a matter of identifying which cliches are appropriate at a given point and recognizing how lower level components are aggregated to form higher level components. The situation is the same, in reverse, for understanding existing systems/software -- instantiations of components represent higher level abstractions. Based on the above, we need to look at approaches to design that are based on reasoning by analogy (e.g., Case Based Reasoning) with an overlay of rule/production-based logic to guide the criteria for judging similarity (which will vary with context). Projects might demonstrate technology to:

- Define schema/frames for representing software components.
- Demonstrate component (cliche) recognition in existing code.
- Demonstrate ability to identify needed sub-components (e.g., to provide required function)
- Specify consensus schema/frames for representing software components at various levels of granularity (e.g., subsystem, package/module, statement, expression) and refinement (e.g., architecture, design, code)
- Demonstrate ability to identify needed sub-components, determine appropriate ordering, and identify missing components.
- Conduct initial demonstrations and plan large-scale demonstrations, if justified.

PHASE I: Prototype demonstration and design.
PHASE II: Demonstration of 2 orders of magnitude reduction in cost to modify system.

PHASE III DUAL USE APPLICATIONS: This is a revolutionary approach to the design and adaptation of most systems and software. Its application of planning and Case Based Reasoning will automate the production of all software. Indeed, the earliest applications could well be in business areas where the "business rules" to be implemented are well understood.

KEYWORDS: Adaptive Software, System Synthesis, Engagement Planning, Production Planning.

SB001-014 TITLE: Visualization of Information in Support of Asymmetric Operations

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Military planners use detailed maps of terrain, combined with relevant information derived from a variety of sources to understand potential actions/counter actions that are available to both himself and his opponent. This approach has worked well for hundreds of years since most military operations occurred in physical space. However, part of the shifting in military warfare present today is from action in 3D space, to asymmetrical threats that require dealing with the gathering, interpretation and use of information as a military weapon. Military planners today have sophisticated tools available to visualize 3D space, such as paper or electronic representations of terrain, but they do not have an equivalent for visualizing the “information space”. This effort is designed to focus on this limitation by providing military commanders with ways of displaying what information someone knows, how he knows it, how good it is and how what someone knows (or does not know) can be used to manipulate the outcome of a military engagement (or to prevent such an engagement). Develop techniques that allow military planners to determine what military information, relevant to their tactical situation, is available to an adversary, and present the data in such a way that a military planner can use the data for course of action development.

DESCRIPTION: Military planners rely on information derived from a wide range of sources as the basis of their decision making process. This information represents the collective understanding of the current situation of friendly, enemy and neutral components. It also represents the best understanding of what information an opposing force may have as well about his current situation. To obtain the goals set forth for a particular operation, planners must be able to quickly integrate relevant data and develop an understanding of both current and future situations, so as to rapidly take advantage of opportunities as they present themselves. Information Operations is a term broadly used to describe the emerging area of military operations related to understanding information flow on a battlefield and how it effects military outcome. By being able to better understand how this process occurs, military commanders are better able to understand and manipulate a situation to either take advantage of a lack of situational awareness by an opposing commander, or by doing things that add to his confusion of the situation. However, in order to do this, methods of displaying the “information terrain map” must be developed.

PHASE I: Identify advanced concepts/algorithms which will offer potential improvement in the ability of military commanders to understand what information is available and how it can impact his planning and execution process. In particular, visualization techniques should be used that allow a commander to rapidly understand the “information terrain” as well as provide techniques to analyze potential actions that could be taken based on this information. Low to medium technical risk and high potential for successful development will be included in the technical merit selection criteria. Identify experimentation techniques and metrics that would be used in a Phase II effort to validate.

PHASE II: Develop and test one or more techniques/algorithms selected in Phase I by integration within a command and control planning structure as proposed in Phase I. Execute experiments to validate the concepts/algorithms developed against the metrics identified in Phase I.

PHASE III DUAL USE APPLICATIONS: The basis of any planning systems, whether it's used within a military context or for corporate strategic planning, is information. The art to planning is understanding who knows what and what advantage can be gained by understanding an opponents lack of situational awareness. The opponent could be another military commander, but could also be a corporate competitor. Although the information critical to planners within a military or corporate environment will be different, the underlying technologies necessary for visualization of the information "terrain" are similar.

KEYWORDS: Visualization, Information Operations, Information Space.

SB001-015 TITLE: Adversarial Reasoning

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop and demonstrate a technique for assessing the risk posed by enemy actions that can be applied during interactive specification of a course of action (plan).

DESCRIPTION: Command and control systems incorporate a variety of tools to assist command staff in interactive specification of a course of action. The process is still time consuming, and often results in plans that are infeasible, either because they are physically impossible, logically inconsistent, or vulnerable to obvious enemy counteractions. In today's environment of asymmetrical threats, the range of factors that must be considered by planners has increased. Ideas for testing the physical and logical feasibility of individual planned actions during plan specification have been demonstrated. These ideas portend significant reductions in plan development time by assisting planners in avoiding infeasible actions. Implementation of tools that perform these tests will not assess the risk of plan failure due to potential counteractions of the enemy. Techniques are needed that incrementally assess planned actions against enemy counteractions and alert planners when significant risks are uncovered. Incremental testing during plan specification is necessary because planning a single course of action may take hours, and immediate feedback will allow planners to augment or discard risky plans. The value of this assessment increases with the number of factors that must be considered by planners. As additional factors must be considered, the expertise to evaluate the enemies response must be provided by humans or through automated decision support. Adversarial reasoning permits these additional factors to be considered without increasing the number of humans necessary to support the planning process. Applying constraint reasoning and rule-based critique, the primary techniques developed for feasibility testing, are not sufficient for adversarial reasoning. Of course a decision aid should not bother with counter-plans that are physically infeasible. What is necessary is a method for evaluating planned actions against hypothetical counteractions that are both physically possible and consistent with the assumed capability and intent of the enemy force.

PHASE I: Develop a concept of operations for an adversarial reasoning component to an interactive planning aid. Describe how evaluation would proceed, including how it would relate to physical feasibility testing, specification of possible enemy intent, and other significant factors. The concept of operations for this aid must include the ability to include traditional combat factors as well as asymmetrical factors. Describe the theoretical basis for the process, contrasting or comparing it to adversarial reasoning approaches in the literature, including Game theory, legal reasoning, and argument theory. Develop a plan for implementing and testing a demonstration prototype in Phase II.

PHASE II: Develop a proof-of-principal prototype based on the concept developed in Phase I. Develop and conduct experiments to test the effectiveness and usefulness of the approach. Document the research and experiments.

PHASE III DUAL USE APPLICATIONS: The development of adversarial reasoning algorithms and technologies will have a very strong commercial potential, to include a wide range of business planning and commercial gaming applications.

KEYWORDS: Adversarial Reasoning, Asymmetrical Threats, Planning, Risk Assessment.

SB001-016 TITLE: Real-Time Service Provisioning Over Unreliable Networks

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Creation of scalable technologies that enable real-time provisioning of reliable and secure end-to-end network services with pre-defined quality-of-service over unreliable, heterogeneous networks.

DESCRIPTION: Research and development leading to tools that enable real-time provisioning of scalable end-to-end secure and reliable services with quality of service, over unreliable, heterogeneous networks. Efforts must clearly define quality of service, to be studied and implemented, through quantifiable measures such as bandwidth guarantees, delay, jitter etc.; and reliability, through measures characterizing service interruption times incurred by path protection algorithms that provision alternate service paths in the event of failures. Efforts may be restricted to, Internet protocol (IP) and/or asynchronous transfer mode (ATM) networks, and to wired or wireless networks or a combination of them, but must address end-to-end provisioning leveraging any local mechanisms already defined in the networks. Efforts of interest include provisioning of virtual IP paths that are compatible with, and leverage, emerging backbone technologies such as multi-protocol label switching and differentiated services. Algorithms research areas of relevance include: algorithms for classifying packets, for efficient provisioning of virtual paths and network resources to packet classes, and for path protection. Mechanisms for security may use Internet protocol security (IPSec) definitions or others with similar capability. Efforts may build on existing algorithms, or create new ones, but in all cases the proposals must clearly identify the protection speed, scope of quality of service to be implemented, type of networks for which the tool is applicable, and limitations of the approach.

PHASE I: In detail, define the network environment. Define and evaluate algorithms for packet classification, for optimal provisioning of paths and network resources to packet classes, and for path protection. Identify candidates for implementation.

PHASE II: Implementation of the algorithms, from Phase I, in efficient software/hardware combination. Integration of these components into existing networks. Demonstrate system that can provably achieve 100-300 msec provisioning/protection times in a nationwide network; and greater than 95% delivery of implemented quality of service.

PHASE III DUAL USE APPLICATIONS: The ability to provision secure and reliable services over IP networks is an important extension of the capabilities of these networks. Enterprises and organizations that require mission-critical applications and real-time service integration will benefit from this technology.

KEYWORDS: Network Service Provisioning, Reliable and Secure Networks, Quality-of-Service, High-Speed Networks, Wireless Networks, Multi-Service Networks.

SB001-017 TITLE: Applications for Multi-Terabit Networking

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Exploit the new high-speed networking technology capable of supporting tens and hundreds trillion bits (Terabit) of information per second to enhance or revolutionize today's real-time network based applications and operations. Demonstrate networked applications that run over such multi-terabit networks and individually sink and source information streams that are three to four orders of magnitude greater in speed or capacity than are currently available over data networks. Specifically, prototype and conduct experiments with end-to-end applications that require sustained or burst rates of 100 Megabits per second to several Gigabits per second unlike today’s limited applications that at best can handle up to few Megabits per second.

DESCRIPTION: Network centric operations is a concept that has great support in both industry and DOD. There are a plethora of opportunities to employ this model in several operating environments and to develop requisite personnel training programs needed to support the operation of the network in Government and private sector applications. However, a clear and compelling examples of the network centric behavior is not readily forthcoming especially for those enabled by Multi-Terabit networks that can offer applications end to end bandwidths of greater than 100 Megabits per seconds. An overall architecture that supports new business models and operational paradigms in a high-speed network environment needs to be investigated. The business processes developed to exploit the capabilities offered by the network architecture must be adaptable to new business methods that focus on increasing operating efficiencies. Moreover, new applications and uses for this new network environment must be well defined, and criteria for quantifying operating efficiencies must be established. The integration of business processes that support the seamless use of data and information from distributed repositories is one example of an area that should be explored in this work. Another example is the real-time streaming of high-resolution video and audio streams to users, or sensor output.

PHASE I: Develop an information architecture that incorporates a high-speed national network, create methods for protecting data and information, and develop business processing models. Conduct analysis to predict the affordability and improved performance that will be gained in using the integrated system. There must be a plan for experiments to determine effectiveness of the implemented architecture.

PHASE II: Build and implement a prototype high-speed networked application that demonstrates the ability to manage and protect information. Experiments must be conducted on wide-area networking test bed involving multiple users at distributed locations. Evaluate the affordability from an infrastructure cost perspective, and measure the business process improvements realized through the implementation.

PHASE III DUAL USE APPLICATIONS: Demonstrate the technology operating on the high-speed network and clearly show the cost savings and effectiveness of the approach for both a key commercial area and a critical military application.

KEYWORDS: High Speed Networking, Gigabit, Sec Applications, Embedded Processors

REFERENCES: http://www.darpa.mil/ito/research/ngi/index.html

SB001-018 TITLE: Alternative High-Bandwidth Communications Technologies

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Creation of alternative, secure, high-bandwidth communications methods for distributed computing, making innovative use of commercial off the shelf technology.

DESCRIPTION: Research and development leading to the innovative use of COTS systems and technologies that will allow geographically distributed individuals to communicate and collaborate security. Current technologies allow fixed network users to participate in local intra-organizational private networks. Also, remote users are allowed to connect to these same networks, although communications are not secured. Research efforts should address the application of current fixed private network technologies to the organizational remote user, who needs secure access while remotely connected. Research must consider higher bandwidth capabilities available from commercial interests. Additionally, capabilities for incorporating wireless users must be demonstrated.

PHASE I: Develop a small operational prototype that provides virtual private network capabilities to remote users over high-bandwidth connections, providing distributed computing functionality for the “road warrior”.

PHASE II: Expand the prototype to include wireless users. Document the scalability of the application, showing how it could be applied to additional operational models and larger communities, such as the military.

PHASE III DUAL USE APPLICATIONS: Develop a small operational prototype of the secure remote user and secure wireless capability for 20 distributed users and place the prototype into operation within a cross-organizational environment. The development of innovative distributed computing methodologies will be immediately valuable to the DoD, addressing current inter-organizational communication difficulties. Additionally, the private sector is rapidly becoming aware of the dangers of unprotected communications on the Internet. Innovative solutions that reduce the risk of Internet use will be highly valuable.

KEYWORDS: Distributed Computing, Virtual Private Network

SB001-019 TITLE: Software Applications for Asynchronous Collaboration

KEY TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective of this effort is to design and develop applications that go beyond the current e-mail and shared files in supporting asynchronous collaboration in working groups. These applications should support group and situation awareness while reducing the overhead involved in explicit collaborations.

DESCRIPTION: Recent efforts in collaboration software have focused on synchronous collaboration (e.g. desktop video conferencing, application sharing). While these tools are useful in spanning distances, our problem is often on spanning time – hence asynchronous collaboration tools are needed. The traditional asynchronous tools of e-mail and shared files have not changed significantly since they were first introduced. We are seeking software technologies to support individual awareness of group work, including individually customizable organization of group communications; intelligent and adaptable information filtering and dissemination techniques; technologies and visualizations for structural differencing; and applications and visualizations for managing common information spaces. We seek technologies to support group communications, work flow, work products, and their integration. Applications must operate on heterogeneous platforms and scale to support hundreds of users. Efforts can include workflow types of applications, applications to support messaging within the context of work and structuring of messages in the context of that work, applications to collect, organize, and distribute organizational memory, as well as tools to allow collaborators to customize asynchronous applications to their particular domain. Novel applications are encouraged. Applications must have good user interfaces including visualizations where applicable.

PHASE I: In detail, define the application and create a prototype. Document one or more scenarios in which the application should produce significant benefits for a working group.

PHASE II: Fully implement the application using user centered design methodology. Conduct experiments using one of the scenarios from Phase 1 and document measurable benefits.

PHASE III DUAL USE APPLICATIONS: The applications will be tested within a military exercise or in a commercial scenario. These applications will impact tasks requiring the integration of information from distributed working groups. Typical domains include military planning activities, aircraft operations, medical diagnosis, disaster relief, manufacturing, and education.

KEYWORDS: Asynchronous Collaboration, Awareness, Group Ware.

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SB001-020 TITLE: Representations and Protocols for Universal Access to the World-Wide Web

KEY TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Creation of extensible markup language (XML) versions and accompanying protocols for serving diverse hand-held devices with content and modality of information from World Wide Web servers that is matched to their capability.

DESCRIPTION: XML and accompanying representational standards have created the capability for "writing once and publishing everywhere." XML enables this by tagging content to describe its meaning, independent of the display medium. "Stylesheets" reformat the work automatically for various devices. This is a call for proposals to push the development of XML-based representations and stylesheet translators that further enable the development of a wide variety of different portable, wireless devices. Some devices may be voice-only, others combinations of voice, text and image. The intent is to create widely-accepted representations and processes to further enable the diversity of such devices by ensuring their seamless interoperation with the majority of the content of the World Wide Web.

PHASE I: In detail, define the approach to representation and translation tools that maximize efficiency with respect to diverse services, to be supplied to a wide range of devices. The deliverable will be a test-bed server that works with a sample of cutting-edge devices.

PHASE II: Create a stylesheet translator that enables dialogic interaction with content-full web sites such that effective telephonic interaction with the content can be obtained automatically. The style sheet will be evaluated by subjects “browsing” the web site by using only a telephone and spoken dialogue.

PHASE III DUAL USE APPLICATIONS: Militarily relevant devices for a variety of different contexts will be proposed and tested against the capabilities of universal access across the spectrum of military needs. In addition, the needs of the physically and cognitively disabled citizens will be addressed in terms of providing equal access to the contents of the World Wide Web.

KEYWORDS: World Wide Web, XML, Stylesheet, Extensible Stylesheet Language, Voice-Enabled Browsing, Multimodal Dialogue Systems, Internet Protocols and Standards.

SB001-021 TITLE: Read-Out Technology for Uncooled Thermal Imaging Arrays

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Development of new concepts for reading and addressing multi-element thermal imaging arrays with a low noise detector interface that introduces minimum detector signal loss.

DESCRIPTION: Substantial progress has been made in thermal imaging arrays that operate without the burden of cryogenic cooling. Arrays with thermal sensitivity of approximately one hundred milli-degress Kelvin are routinely produced, and research devices have achieved substantially greater thermal sensitivity. Enhanced performance has led to new applications in both commercial and military systems. This flood of new applications has also stimulated interest in higher performance for specialized applications and to improve yield margin to further reduce cost. Investigations of array performance indicate that the detector read-out mechanism remains a barrier, but that substantial improvements are possible with new concepts and novel approaches. Fundamentally, the read-out must address each detector in the array, determine the thermal signal at the detector and convert the information to an electrical signal. Conventional techniques employ an electrical read-out, similar to commercial visible imaging arrays. This read-out makes contact to the detector, resulting in some loss of thermal signal. Ideally, new concepts in detector array read-out technology are desired to eliminate or drastically reduce the signal loss at the detector, and provide for a detector that performs at or near the theoretical limit. Characteristics of the new approaches include electronic circuits for ultra-low noise, especially one-over-f noise; methods to reduce thermal loss at the detector; technology to integrate the detector with the read-out; and signal processing to compensate for non-uniformity in the array. These characteristics must be integrated into an array capable of being produced with high pixel density, and of course, at low cost.

PHASE I: The design and model for the thermal detector read-out circuit will be developed. This will include the optical, electrical, and if appropriate, mechanical properties necessary to determine the performance of the device. The model will be used to analyze noise mechanisms and the potential for operation at the thermal performance limit.

PHASE II: Devices will be designed and fabricated to demonstrate the read-out concept, and measurements made to compare to theoretical predictions. Prototype arrays will demonstrate the viability of meeting thermal imaging performance metrics. The arrays should demonstrate thermal sensitivity in a laboratory environment, and show the initial feasibility of large high-density image sensors.

PHASE III DUAL USE APPLICATIONS: Multiple applications exist for the thermal imaging cameras in both military and commercial sectors. Improvements in thermal sensitivity and simplification of array read-out technology will reduce camera cost and enhance performance, further expanding the applications base. Examples of applications for the low cost thermal imaging include: rifle sights, night driving, surveillance, police and firefighter applications, and industrial process control.

KEYWORDS: Thermal Detectors, Read-Out Technology, Uncooled Infrared, Imaging Technology.

SB001-022 TITLE: <u>Integrated Microfluidic Technologies for Molecular Level Manipulation of Biological Fluids</u>

KEY TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To develop microfluidic technologies that enable the chip-scale integration of processes to interface, sample, manipulate, detect body fluids (blood, interstitial fluids, saliva, perspiration, etc.) at the molecular level.

DESCRIPTION: Research and development of innovative solutions towards the complete integration of microfluidic components, fabrication processes, and biological/chemical assays on chip-scale microsystems. These efforts take current microfluidic technologies, many which are developed in the current Microfluidic Molecular Systems (MicroFlumes) Program, and develop chip-scale devices specific for interfacing to body fluids for continuous monitoring of physiological responses. The detection of proteins through “cellular-level gene expressions” and nanotechnology for molecular level probing are highly encouraged. On the other side of the spectrum, micromachining technologies for heterogeneous integration of microfluidic components with different materials are sought. Additional efforts encouraged include device technology that interface with living creatures for drawing/injecting body fluids, novel separation/mixing techniques, single processes combining detection and sample preparation, on-chip reconstitution, on-chip fluidic manifolds to interface with biochip arrays, pumping/valving devices and schemes for multiplexing arrays of valves and pumps.

PHASE I: Theoretical/computational proof-of-concept and comparison with existing state-of-the-art technologies. Design of prototype devices and plans to micromachine devices.

PHASE II: Development of prototype micromachined device. Testing to compare with Phase I predictions will be required.

PHASE III DUAL USE APPLICATIONS: Microfluidics technologies developed under this topic will be the basis for embedded chips on soldiers to monitor physiological signatures for early detection of bio-warfare agent exposure, triage of bio events, and vital signs monitoring. An example for a commercial application is the continuous monitoring of high-risk, post-operation patients for the first sign of sepsis, infection, or pressure drop.

KEYWORDS: Microfluidics, Nanotechnology, Molecular Recognition, Integrated Chips, Continuous Monitoring.

SB001-023 TITLE: <u>Lasers for Optoelectronic Enhancement of Analog to Digital (A/D) Converter Performance</u>

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Promote the development of laser modules that take advantage of emerging high repetition rate mode locked laser technologies to enhance the performance of high speed (high sampling rate) A/D converters.

DESCRIPTION: Progress toward advancing the technology for very-high-resolution, high-sampling-rate A/D modules in the range from 1 to 10 Giga-samples-per-second has been extremely slow, due in large part to difficulties in design and fabrication of electronic circuits capable of meeting the required performance. In particular, the generation and distribution of precise timing (clock) signals for these applications could be greatly enhanced through the use of mode-locked laser sources with low (on the order of 10 femtoseconds) pulse-to-pulse timing jitter and low amplitude fluctuations. Innovative approaches are sought for achieving compact modules for generation of very sample mode-locked laser sources using fiber optic and integrated optical components. Candidate technologies include compact, high optical Q resonators based on low-loss fiber ring resonators (Sigma Fiber Laser designs) laser designs and compact, high Q optical resonators based on micro-cavities.

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

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

PHASE III DUAL USE APPLICATIONS: The development of efficient, compact, very stable and portable mode-locked laser sources could find application in commercial and military optical communication systems and in a broad range of other systems applications where timing synchronization over extended distances is important.

KEYWORDS: Optoelectronics, Lasers, Mode-Locked Lasers, Low Jitter Timing Laser Sources.

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SB001-024 TITLE: Terahertz Device Technology

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace, Space Platforms

OBJECTIVE: Development of solid state terahertz devices for operation in the range between 0.3 THz to 10 THz suitable for coherent sources and detectors for use in space-based and short range terrestrial communications, atmospheric sensing, near object analysis, and chemical and biological detection.

DESCRIPTION: The electromagnetic spectrum from 0.3 THz to 10 THz is scientifically rich but relatively technologically poor. The region represents a gap separating electronics, oriented towards transport, from photonics, oriented toward quantum transistors. Devices that mix quantum and transport physics will fill this void. The region offers the potential for a number of applications including space-based and short-range terrestrial or near earth communications, atmospheric sensing, collision avoidance for aircraft and ground vehicles, and near object observation and spectroscopy. To realize this potential the appropriate sources, detectors, and systems need to be developed. Innovative approaches are needed leading to the development, fabrication, and operation of coherent solid state terahertz sources. Efforts may include electrically excited devices as well as those driven by solid state optical lasers. Three terminal devices, and classical approaches, such as Gunn diode oscillators may be considered as long as proper power and efficiency advances are addressed. Highly desired are approaches in quantum wells and tunneling devices, as well as other novel quantum structure approaches. Desired are devices and device concepts that will deliver coherent radiation at potentially milliwatt power level, ultimately coupled efficiently in THz circuits, guided wave structures and antennas. Work is needed in detectors to greatly improve the sensitivity, speed, and bandwidth. Specifically desired are efforts in semiconductor-based quantum well structures and the subsequent development of a useable detector that is narrow band, widely tunable, and yet highly sensitive. Other solid-state approaches may be considered. Approaches toward compact system modules addressing both generation and detection are also of interest.

PHASE I: Clearly demonstrate the feasibility of the proposed approach. Define a device that will deliver up to milliwatts of coherent radiation at specified frequencies in the THz regime. And/or define the detector or detector structure detailing optimal geometry, bandwidth limitations, tunability, and current-carrying capacity. The definition of the device/system-module needs to include principal of operation, material, processing, associated circuit or guided wave structure, and regime of operation.

PHASE II: Build upon Phase 1 work and demonstration of system components and implementation of a prototype. Perform appropriate analysis and modeling, grow the material or structure, fabricate the device and test its performance.

PHASE III DUAL USE APPLICATIONS: Terahertz electronics and photonics have many potential commercial and military applications. Covert communication on the battlefield or in space, chemical agent detection, atmospheric environment sensing, near object detection, material imaging will benefit from new technology in this part of the electromagnetic spectrum. New terahertz electronics will also make possible ultra high speed signal processing.

KEYWORDS: Microelectronics, Photonics, Terahertz, Terahertz Electronics, Communications, Sensing, Heterojunctions, Quantum Wells, Semiconductors, Solid State, Sources, Detectors, Chemical Sensors, Bio-Detection.

SB001-025 TITLE: <u>High Power Semiconductor Devices</u>

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Create technologies for efficient design and fabrication of high power switching electronic devices and circuits, based on silicon-carbide (SiC).

DESCRIPTION: Devices fabricated in high power handling silicon-carbide (SiC) semiconductor material system are emerging. The difficulties in designing and processing SiC devices must be overcome to allow the technology to realize its potential. Results on SiC indicate that devices may handle high voltages and currents, but may also have very high power dissipation density (on order of 1E3 W/sq. cm). Innovative technologies are needed for design, fabrication, and integration of new classes of SiC high-power solid-state electronic components, such as diodes and switches, with conventional sensors and microelectronic control. These new devices and circuits are needed to meet the widespread military and commercial needs for switching devices and integrated circuits that can satisfy the very high-current and high-voltage requirements of power transmission and distribution systems, hybrid- and all-electric vehicles, more-electric aircraft, and other types of electrical equipment and machinery. Forward currents are expected in the 100-1000A range and reverse voltages in the 1000-10000V range. New design and analysis tools that efficiently couple electronic, electromagnetic, and thermal phenomena together may be useful to fully realize the potential of SiC technology. In addition, SiC is a difficult material to process, and innovations in process technology that allow higher yield or advanced device performance may be important. As appropriate, offerors should provide an analysis of current technologies and clearly describe the projected benefits of the proposed approach.

PHASE I: Perform fundamental experiments and computer simulations that confirm feasibility of the technology for application to high power devices.

PHASE II: Develop cost-effective processes or design tools for high power devices. As appropriate, demonstrate critical aspects of developed technology for scaled or intended applications. For design tools, verify accuracy and efficiency of approach.

PHASE III DUAL USE APPLICATIONS: While not yet a mature overall technology, SiC materials and devices have inherent advantages for handling high powers. Commercial and military applications for SiC high power devices and circuits include, uncooled switching devices and integrated circuits for electrical power transmission and distribution systems, hybrid- and all-electric vehicles, more-electric aircraft, and other types of electrical equipment and machinery.

KEYWORDS: High Power Electronics, Design, Fabrication, Silicon.

SB001-026 TITLE: <u>Materials and Tools for Heterogeneously Integrated Microelectronics</u>

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Develop new silicon-compatible microelectronic materials, and design and fabrication tools to enable the efficient implementation of advanced monolithic electronic systems, based on very short channel transistors, and other devices, and their integration in large numbers, focusing on application-specific and signal processing circuits.

DESCRIPTION: The minimum lithographically defined feature size of a silicon field-effect transistor will decrease from the present 180 nanometers (nm) to 25 nm during the next decade. At the 25 nm scale, it will be possible to monolithically fabricate as many as 1E12 transistors, perhaps in more than one layer of active devices. The availability of this large number of devices may allow tremendous flexibility and function in circuit architectures. In addition, it may be possible to heterogeneously integrate alloys such as SiGe selectively, enabling high performance devices. A new class of design and fabrication tools will be required to enable and exploit these capabilities. New cost-effective fabrication tools that enable production of devices on multiple layers or selective formation of silicon alloy devices may be needed. Complexities are also expected in designing and verifying efficient, high performance circuits with such large levels of integration and new design/analysis technologies are needed to solve these problems. Advanced physics-based tools and models are required to better understand the operation and sensitivities of these very short channel devices. It is anticipated that the coupling of design and fabrication will need to be very tight for the terascale integrated circuit. Integrated physical and statistical technology design/analysis tools have proven to be highly effective in devolving the coupling between design and process for the 0.5 and 0.25 micron technology generations. Development and extensions of new technology coupled modeling tools for the 25 nm scale device may be critical to yield circuits at high integration levels.

PHASE I: Determine the necessary features, specifications, and requirements of design and fabrication tools. Develop strategies to develop, integrate, and verify point tools in advance of availability of fully scaled 25 nanometer circuits. As relevant, perform critical lab experiments to verify technological basis of fabrication tool.

PHASE II: Execute the technical approach developed in Phase I. Complete implementation of theories, numerical or analytic solvers, integration of models and code modules, and demonstrate capabilities of prototype design/analysis tools.

Develop plans to support continuous upgrades to tools beyond Phase II. As relevant, develop experimental hardware that conclusively demonstrates fabrication technology and establishes transition path.

PHASE III DUAL USE APPLICATIONS: Semiconductor technologies such as design and fabrication tools have both military and commercial utility. These tools could be used to design, analyze, verify, and ultimately fabricate any type of circuit. Semiconductor technology is being driven by commercial products with high product volumes. The military needs complex, high performance components at low product volumes. The design tools under development in this topic will impact the development of both commercial high volume parts and military high performance parts.

KEYWORDS: Semiconductors, Silicon, Terascale Integration, Computer Aided Design.

SB001-027 TITLE: Automatic Terrain Characterization and Feature Identification in FOPEN SAR Imagery

KEY TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace, Weapons

OBJECTIVE: The objective of this program is to extract topographic, terrain cover and cultural feature information from single and multiple pass FOPEN SAR imagery.

DESCRIPTION: DARPA is currently developing a Foliage Penetration (FOPEN) syn-thetic aperture radar (SAR) system [1] to detect concealed targets. The dual-band sys-tem, operating simultaneously at both VHF and UHF, will begin to collect data in FY00. The VHF radar, which is horizontally polarized, operates from 25 to 88 MHz, while the UHF radar, which is fully polarimetric, operates from 150 to 575 MHz. The radars are mutually coherent. A significant challenge in FOPEN SAR operation is to achieve a high probability of target detection while minimizing the number of false alarms due to forest clutter. Automatic Detection and Cueing (ATD/C) algorithms are being developed for this purpose. It has been observed that the best-performing features for ATD/C process-ing can vary with the characteristics of the foliage (e.g. tree height and density), the slope and roughness of the terrain, the season of the year and other environmental characteris-tics. This effort will develop tools to automatically characterize the local environment so that the optimal set of features can be used in the ATD/C processing. In addition, DARPA plans to investigate FOPEN Ground Moving Target Indication (GMTI) radar. The target tracking performance of such a radar could be significantly enhanced if con-textual background information were available. Information such as road locations and areas in which moving targets cannot operate could be extracted from a FOPEN SAR map or from multiple-pass Interferometric SAR imagery, and provided to the target tracker.

PHASE I: Investigate techniques and develop algorithms that accurately characterize the topography, determine the foliage characteristics and identify cultural features in FOPEN SAR imagery. FOPEN imagery will be made available by the Government to support this effort.

PHASE II: Develop software tools and demonstrate the capability to provide accurate characterizations of the area imaged by the FOPEN radar. The software tools will operate under the Khoros environment used for FOPEN SAR ATD/C processing. The software tools will be provided to the Government with SBIR restricted rights at the conclusion of the Phase 2 effort.

PHASE III DUAL USE APPLICATIONS: The techniques that are developed will be applicable to potential future commercial uses of FOPEN SAR such as developing Land Use and Land Cover map products, monitoring forest resources and performing search and rescue missions. The techniques will also be useful for planning military operations by providing accurate and up-to-date terrain assessments.

KEYWORDS: FOPEN, SAR, Interferometric SAR, Terrain Feature Extraction.

REFERENCES: Davis, M. E. et al, "Technical Challenges In Ultra-Wideband Radar Development for Target Detection and Terrain Mapping", Proceedings of the IEEE International Radar Conference, 1999.

SB001-028 TITLE: Acousto-Optic Spectra-Polarimetric Imaging

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Design and develop acousto-optic spectra-polarimetric imaging system to include acousto-optic crystals and polarimetric imaging spectrometers for application in the visible-near infrared, short wave infrared, and long wave infrared, for the purposes of military target detection.

DESCRIPTION: Advances in imaging spectrometers and acousto – optic materials are making possible the combination of multi/hyperspectral and polarimetric imaging for the purposes of military target detection in cluttered environments. Specifically the combination of these technologies in a compact system would provide significant value to the military. Current concepts indicate specific shortfalls in the following three areas: (1) robust-detailed compact system designs (2) combined multi/hyperspectral – polarimetric target detection algorithms and, (3) long wave infrared/polarimetric acousto – optic materials development.

PHASE I: Develop robust spectra-polarimetric acousto-optic imaging system design. Develop long wave infrared/polarimetric acousto-optic material. Develop combined spectra-polarimetric target detection algorithms.

PHASE II: Develop/build and test prototype spectra-polarimetric acousto-optic imaging system. Fabricate/demonstrate long wave infrared/polarimetric acousto-optic material. Demonstrate/verify performance of combined spectra-polarimetric target detection algorithms against real or simulated data.

PHASE III DUAL USE APPLICATIONS: This system or advances developed could be used in a broad range of military and civilian applications to include security and law enforcement, adverse weather aviation landing systems, medical diagnostics, and search and rescue operations.

KEYWORDS: Sensors, Multi/Hyperspectral, Polarimetry, Optical System, Acousto-Optics.

SB001-029 TITLE: High Power Fiber Lasers

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: The goals of the program are to develop innovative approaches to scale up the output power of fiber lasers to 1 kW from a single aperture.

DESCRIPTION: Fiber lasers with double clad structure are a new generation of diode pumped solid state lasers that are efficient (~ 25 %), have single mode output and can be implemented with air cooling alone. Tens of watts of output power from fiber lasers have been demonstrated. The cavity and pumping scheme are built into a waveguide structure. The guided nature of the fiber laser is self-aligning; therefore the cavity is extremely robust against alignment disruption. The fiber lasers can be mass-produced at low cost. High power fiber lasers have numerous defense applications such as cw lidar sources, pump source for frequency converters for infrared countermeasures and isotope separation. In addition, high power fiber lasers may be coherently combined to provide a potential multi-kilowatt laser sources for tactical battlefield applications.

PHASE I: Define, analyze innovative design concepts for double clad fiber laser architecture for single mode output power of 1 kW from a single fiber. Demonstrate perform fabrication and fiber drawing for the selected designs.

PHASE II: Demonstrate 1 kW single mode output power from a fiber laser.

PHASE III DUAL USE APPLICATIONS: The high power fiber lasers have many commercial applications in graphic arts industry, industrial machining and medical applications. A successful demonstration of higher output power from a single fiber would provide an opportunity to develop a military systems with components available from commercial-off-the shelf.

KEY WORDS: Fiber Lasers, Laser Diodes, Diode Pumping, Cavity, Single Mode, Double Clad Structures.

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SB001-030 TITLE: Advanced Gating Techniques for Planar, High Power Non-Linear, Semiconductors in Advanced Mobile Power Conditioning Applications

KEY TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

OBJECTIVE: Demonstrate advanced gating technique(s) on planar silicon devices.

DESCRIPTION: Present state-of-the-art gating of planar, high power, non-linear, semiconductor devices such as thyristors, gate turn-off thyristors (GTO's), MOS-controlled thyristors (MCT's) and MOS turn-off thyristors is accomplished through plasma spreading as stimulated by the injection of an electric current through the devices gate structure. The gate structure(s) typically share surface area with the emitter in these planar devices. In order to maximize the performance of these devices for high power applications, the gate structure(s) can consume a large fraction of that surface area, thus complicating and compromising the area/volume available for the conduction of load current and heat. This compromise typically forces the necessary area/volume of active semiconductor to increase rapidly with increasing di/dt, current or charge transfer requirements. In the most severe service, as might be found in the switching of advanced rotating machines and high energy capacitive stores in a burst mode, the area/volume of active semiconductor (and therefore, device count) becomes unmanageable for many future applications. Devices made from wide bandgap semiconductor materials such as silicon carbide have the potential to operate at higher temperatures, higher di/dt's, and higher current densities than the present state-of-the-art devices in silicon. However, the ultimate performance of these devices will also be compromised if alternative gating techniques are not developed. Therefore, the proposed techique(s) should be applicable to devices made from candidate wide bandgap materials as well as silicon.

PHASE I: Demonstrate advanced gating technique(s) on planar silicon devices. Show relevance of the approach for application in wide bandgap devices.

PHASE II: Demonstrate advanced gating technique(s) on wide bandgap devices. Implement the gating technique(s) on silicon or wide bandgap devices of substantial area for direct application in advanced, compact, mobile power conditioning.

PHASE III DUAL USE APPLICATIONS: Applications include load leveling and peak demand management for both military and commercial electric and hybrid electric vehicles.

KEYWORDS: Energy Storage, Semiconductor Materials, High Temperature Electronics, Wide Bandgap Devices, Switching.

SB001-031 TITLE: SiC Inverter

KEY TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Development of a SiC-based inverter to provide power for the traction motors for an electric or hybrid electric ground vehicle.

DESCRIPTION: Using SiC switches in electric or hybrid electric vehicle traction inverters promises to reduce significantly the size of the propulsion system including the supporting cooling system. Recent advances in SiC devices indicate that SiC power semiconductor switches will soon be available for use in inverters. The unique performance characteristics and cooling requirements of the devices need to be applied to inverter design. The results should be an inverter that can be integrated into an electric or hybrid electric vehicle in less space than current silicon-based power electronics. The design concept should be scaleable across the size range of future hybrid electric military vehicles.

PHASE I: Design and analyze a SiC-based inverter for an electric or hybrid electric ground vehicle. Estimate the effect on performance and design of using the proposed inverter in a hybrid electric military ground vehicle such as a HMMWV, RST-V, or larger combat vehicle.

PHASE II: Build and test the SiC-based inverter. Determine one or more paths to military application and commercialization.

PHASE III DUAL USE APPLICATIONS: Electric and hybrid electric vehicles are being developed for all sizes of vehicles, from motorcycles, to cars and to heavy trucks. Hybrid electric vehicle technology is expected to be used for future ground vehicles for the military.

KEYWORDS: SiC, Inverters, Hybrid Electric Vehicles, Electric Vehicles.

SB001-032 TITLE: Group Target Tracking

KEY TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Development and demonstration of theory, algorithms and software for tracking groups of targets with inter-target motion constraints.

DESCRIPTION: Current Multiple Hypothesis Tracking (MHT) technology provides a rigorous approach to the development of tracking algorithms and software based upon statistical estimation theory. The theory has been widely applied to a variety of sensor systems, including the Discoverer II space-based radar system. A limitation of the current theory is that the targets being tracked are required to move independently of one another. The removal of this limitation would greatly extend the domain of applicability of the MHT technology. A straightforward example is the case of military vehicles moving together as a unit. Exploiting the correlations in the movements of the vehicles in the unit should provide improved tracking performance; e.g., by estimating the behavior of vehicles in the unit that are not detected during a particular sensor revisit using the behavior of the vehicles in the unit that are detected. Alternatively, by tracking the unit as an entity rather than the vehicles in the unit individually, it should be possible to use lower revisit rates and hence less sensor resources. A less obvious example is the case of a military vehicle observed by a high resolution radar. Here it is desired to track the bright points in the radar return to estimate the 6-dimensional motion of the vehicle in order to form a Moving Target Image (MTIM). Assuming that these bright points arise from features on the surface of the vehicle, their motion is related by rigid body constraints.

PHASE I: Develop the necessary theoretical extensions and approximations necessary to achieve a computationally feasible solution. Implement a prototype algorithm to demonstrate the application of the theory.

PHASE II: Develop a software package implementing the algorithms. Demonstrate the software using data from one or more application domains.

PHASE III DUAL USE APPLICATIONS: There is a growing requirement for automatically processing video imagery in the industrial security, transportation, and entertainment industries. The problem of tracking extended objects using features derived from processing individual video frames is identical to the group target tracking problem (where the features correspond to targets). Thus, the software developed should have wide commercial applicability.

KEYWORDS: Target Tracking, Radar, Video.

SB001-033 TITLE: <u>Component Technologies for Closed-Loop Adaptive Flow Control</u>

KEY TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Development of new actuator and actuation system concepts, and/or more powerful, more effective, larger-scale actuators to effect closed-loop active flow control for enhanced air vehicle performance.

DESCRIPTION: An initial round of innovative adaptive flow control actuators and concepts are being evaluated under existing DARPA contracts in the Micro Adaptive Flow Control Program for selected military system applications. These concepts include (but are not limited to) aspiration controls for highly loaded compressor blades, active control of complex downwash flows for tilt-rotor aircraft, active flow control of retreating blade stall for rotorcraft, smart aeroelastic mesoflaps for shock wave/boundary layer control in inlets, and reconfigurable piezoelectric synthetic jet actuators for flight controls. The full potential for adaptive flow control applications, particularly in air platforms, is limited by the available technology for innovative and robust actuators, sensors, and controls. We wish to accelerate development of innovative flow control component technologies that can ultimately be leveraged into large system benefits. Currently the application of adaptive flow control to full systems is limited by actuator output, particularly with respect to actuator bandwidth and energy delivered to the flow. Innovative high-output actuators that implement smart materials, novel energy delivery methods, compliant mechanisms, and high power densities should be considered. Demonstration of the contribution to typical full-scale implementations should also be considered.

PHASE I: Define the new component technologies which will have large benefits when applied to adaptive flow control, demonstrate feasibility of the new technology, and quantify the expected benefits.

PHASE II: Develop a full implementation of a technology that has crucial benefits to adaptive flow control. Demonstrate prototype devices and establish their range of performance.

PHASE III DUAL USE APPLICATIONS: Adaptive flow control technology has a wide range of applicability in the civilian community in situations where viscous effects in flows produce performance degradation. In addition to the applicability of this technology to commercial air transports, adaptive flow control can show system benefits in diverse areas such as ground vehicle drag reduction, ventilation systems, and chemical processing plants.

KEYWORDS: Active Flow Control, Adaptive Flow Control, Flow Actuators, Synthetic Jets, Unsteady Aerodynamics, Viscous Flows

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