U.S. ARMY 97.2
SUBMISSION OF PROPOSALS

Topics

The Army participates in one solicitation each year with a coordinated Phase I and Phase II proposal evaluation and selection process. The Army has identified 167 technical topics for this solicitation which will address the Technology Areas in the Defense Technology Plan and the Army Science and Technology Master Plan. The commercial potential for each of these topics has also been identified.

Operating and Support Cost Reduction (OSCR)

The U. S. Army spends a large part of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics. The Army is seeking ways to reduce these costs as a broad Acquisition Reform initiative. To this end, the Army has implemented the Operating and Support Cost Reduction (OSCR) Program. This solicitation includes 45 topics which address specific OSCR concerns identified by the Army's research and development community. The OSCR topics have been grouped together at the end of the Army topics to benefit offerors who are specifically interested in cost reduction applications.

Technology Areas

Each Army SBIR topic is tied to one of the 19 technology areas, listed below, which are described in the Army Science and Technology Master Plan.

1 Aerospace Propulsion and Power
2 Air and Space Vehicles
3 Chemical and Biological Defense
4 Individual Survivability and Sustainability
5 Command, Control, and Communications
6 Computing and Software
7 Conventional Weapons
8 Electron Devices
9 Electronic Warfare/Directed Energy Weapons
10 Civil Engineering and Environmental Quality
11 Battlespace Environments
12 Human-Systems Interface (HSI)
13 Manpower, Personnel, and Training
14 Materials, Processes, and Structures
15 Medical and Biomedical Science and Technology
16 Sensors
17 Ground Vehicles
18 Manufacturing Science and Technology
19 Modeling and Simulation (M&S)

Proposal Guidelines

The maximum dollar amount for Army Phase I awards is $100,000 and for Phase II awards is $750,000. Selection of Phase I proposals will be based upon technical merit, according to the evaluation procedures and criteria discussed in this solicitation document. Due to limited funding, the Army reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded. To reduce the funding gap between Phase I and Phase II, the Army follows a disciplined milestone process for soliciting, evaluating, and awarding superior Phase II proposals. Phase II proposals are invited by the Army from Phase I projects which have demonstrated the potential for commercialization of useful products and services. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing developed technology. Cost sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR fast track (see section 4.5). Commercialization plans, cost sharing provisions, and matching funds from investors will be considered in the evaluation and selection process. Phase II proposers are required to submit a budget for a base year (first 12 months) and an option year. Phase II projects will be evaluated after the base year prior to extending funding for the option year. Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered. Awards are made contingent on availability of funding and successful completion of negotiations.

Submission of Army SBIR Proposals

All proposals written in response to topics in this solicitation must be received by the date and time indicated in Section 6.2 of the introduction to the DoD solicitation. Be sure that you clearly identify the specific Army topic which your proposal addresses. All Phase I proposals (one original and four copies) must be submitted to the Army SBIR Program Office at the address shown below:

Dr. Kenneth A. Bannister
Army Research Office-Washington
Room 8N23
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

Recommendation of Future Topics

Small businesses are encouraged to suggest ideas which may be included in future Army SBIR solicitations. These suggestions should be directed at specific Army research and development organizations.

Inquiries

Inquiries of a general nature should be addressed to:

Dr. Kenneth A. Bannister
Army SBIR Program Manager
Army Research Office - Washington
Room 8N23
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

LTC Joe McVeigh
Army SBIR Program Coordinator
HQDA
OASA RDA
Pentagon, Room 3E486
Washington, D.C. 20310-0103
(703) 697-8599

ARMY SBIR PROGRAM
POINTS OF CONTACT SUMMARY

U.S. Army Materiel Command

CMD	POC	PHONE	TOPICS (A97-)		OSCR TOPICS
ARDEC	John Saarmann	(201) 724-7943	001 thru 004	and	123 thru 132
ARL	Dean Hudson	(301) 394-4808	005 thru 021	and	133 thru 140
ARO	LTC Ken Jones	(919) 549-4200	022 thru 028	and	141 thru 145
AVRDEC	Ann Smith	(757) 878-0155	029 thru 037	and	146 thru 147
CECOM	Joyce Crisci	(908) 427-2665	038 thru 063	and	148 thru 150
ERDEC	Ron Hinkle	(410) 671-2031	064	and	151 thru 153
MICOM	Otho Thomas	(205) 842-9227	065 thru 073	and	154 thru 158
NRDEC	Bob Rosenkrans	(508) 233-5296	074 thru 077	and	159 thru 160
STRICOM	Admiral Piper	(407) 384-3935	078	and	161 thru 164
TARDEC	Alex Sandel	(810) 574-7545	079 thru 090		
TECOM	Rick Cozby	(410) 278-1481	091 thru 096		

Deputy Chief of Staff for Personnel

ARI	Joe Psotka	(703) 617-5572	097 thru 099		

U.S. Army Corps of Engineers

CERL	Dave Moody	(217) 373-7228	100		
CRREL	Sharon Borland	(603) 646-4735	101 thru 102		
TEC	June Jamison	(703) 428-6631	103	and	165
WES	Phillip Stewart	(601) 634-4113	104 thru 105		

Surgeon General

MRMC	Herman Willis	(301) 619-2471	106 thru 119		

U.S. Army Space and Strategic Defense Command

SSDC	Ed Bird	(205) 955-4871	120 thru 122		166 thru 167

DEPARTMENT OF THE ARMY
PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to assure that your proposal meets the Army SBIR requirements. Failure to meet these requirements may result in your proposal being returned without consideration. Do not include this checklist with your proposal.

_____ 1. The proposal is limited to only ONE ARMY solicitation topic.

_____ 2. The proposal is 25 pages or less in length. (Excluding company commercialization report.) Proposals in excess of this length will not be considered for review or award.

_____ 3. The Cover Sheet (Appendix A) has been completed and is PAGE 1 of the proposal. The copy containing original signatures is included on the original proposal.

_____ 4. The proposal budget may be up to $100,000 and duration does not exceed six months.

_____ 5. The Project Summary Sheet (Appendix B) has been complete and is PAGE 2 of the proposal.

_____ 6. The Technical Content of the proposal begins on PAGE 3 and includes the items identified in Section 3.4 of the solicitation.

_____ 7. The Technical Abstract contains no proprietary information, does not exceed 200 words, and is limited to the space provided on the Project Summary Sheet (Appendix B).

_____ 8. The proposal contains only pages of 8 1/2" X 11" size. No other attachments such as disks, video tapes, etc. are included.

_____ 9. The proposal contains no type smaller than 11 point font size (except as legend on reduced drawings, but not tables).

_____ 10. The Contract Pricing Proposal (Appendix C) has been completed and is included as the last section of the proposal.

_____ 11. The final proposal is stapled in the upper-left-hand corner, and no special binding or covers are used.

_____ 12. An original and four copies of the proposal are submitted.

_____ 13. The Company Commercialization Report (Appendix E) is included. (This report does not count towards the 25 page limit)

_____ 14. If notification of proposal receipt is desired, then a self-addressed stamped envelope and a copy of the Notification Form (Reference A) in the back of the solicitation book must be sent with your proposal.

_____ 15. The proposal must be sent registered or certified mail, postmarked by July 9, 1997, or delivered to the Army SBIR Office no later than July 16, 1997, 2:00 p.m. local time as required (see Section 6.2).

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U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A97-001 TITLE: Advanced Sensors for Weapon Stabilization and Fire Control

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop and demonstrate low cost, high performance weapon stabilization and fire control sensors, enabling optimal sensor fusion algorithms and innovative fire control implementation paradigms.

DESCRIPTION: Recent developments in smart materials such as piezoceramics, optical fibers, and in Microelectromechanical Systems (MEMS) have created innovative and unique opportunities to improve existing stabilization and fire control sensors while simultaneously pushing the envelope with new devices. Along with the development of new fire control and weapon stabilization sensors comes the need to optimize the fire control equations and the sensor fusion algorithms required to meet the needs of future combat systems.

PHASE I: Develop devices to improve the performance of high performance weapon stabilization and fire control systems. Formulate advanced fire control and sensor fusion optimization algorithms for turreted weapon systems, for both direct and indirect fire missions. Determine the performance, robustness and stability of the complete stabilization and fire control system utilizing advanced computer-aided development tools, simulations and real-time hardware/software implementations.

PHASE II: Develop fully functional prototypes in an integrated design and test environment. Hardware in-the-loop implementations using dynamic models and real-time, multiprocessor-based rapid prototyping systems for laboratory test bed evaluations. Optimize developmental hardware and software based on laboratory test data and provide technical documentation on algorithms and hardware.

PHASE III DUAL USE APPLICATIONS: The results of this work have a very high probability of being commercialized within the DoD and industry. The algorithms and equations will enhance the rapid prototyping environment for improving modern digital servo controls through the integration of recent developments in smart materials. These equations and algorithms will be developed for smart materials independent of the applications they are being used for. This SBIR effort will support development of algorithms and equations which can be applied to systems requiring disturbance rejection stabilization for improved accuracy, sensor fusion and integration, motion detection, auto trackers, vibration reduction, tip control, system deformation, precision machining, stabilization of nonlinear hydraulic actuators, etc. The effort will also focus on determining where it is best to integrate smart materials as part of the system in order for them to be most effective for feedback and control. These algorithms and equations will improve the ability of smart materials as they are applied to military control systems (I.e. fire control and weapon stabilization) or industrial control systems (I.e. part identification, assembly line, multi-sensor integration, autonomous pick and place operations, plane engines, turbine blade, robotic control in factory automation, disarming bombs, precision motions and operations, drum vibration in copier machines, automobile noise reduction, active suspension systems for cars, trucks, heavy machinery, etc.). Fire control and weapon stabilization applications will be the test cases for the equations and algorithms developed under this proposal.

A97-002 TITLE: Cubyl and Adamantyl Derivatives for Liquid Crystals

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: The focus will be on the use of inert intermediates produced in synthetic research of cage explosives, e.g., cubyl and adamantyl carbonyl chlorides, to prepare morphologically stable advanced liquid crystal materials.

DESCRIPTION: Cubyl and adamantyl carbonyl chlorides are near precursors for more powerful explosives based on such cage forms. Octanitrocubane, for example, is a super explosive that is anticipated to provide about 30% more explosive power than LX-14, the military's most powerful current explosive formulation. Chlorocarbonyl derivatives of cubanes and adamantanes have their functionalities in a spherical symmetry, and they can be derivatized as vitrifiable liquid crystals with elevated glass transition temperatures. These materials will be widely applicable as ingredients in a variety of civilian and military display devices which have a large market.

PHASE I: Focus on the derivatization of cubyl and adamantyl intermediates to prepare morphologically stable ingredients for liquid crystals. Address issues such as :(1) Fundamental understanding of vitrification in organic materials; (2) Molecular design strategies to optimize various properties for intended applications, such as glass and mesomorphic transition temperatures in addition to optoelectronic properties. In the case of vitrified liquid crystals address: (1) Molecular alignment

and packing in relation to chemical structure and processing conditions; and (2) Kinetics of defect formation and annihilation kinetics and processing techniques to achieve defect- free devices.

PHASE II: Prepare a variety of above derivatives and conduct an in-depth study of their properties in liquid crystal device environment. Select suitable compounds for Phase III work.

PHASE III DUAL USE APPLICATIONS: Liquid crystal materials are essential ingredients in military and civilian display devices such as camouflage items, night vision binoculars, heads-up displays, TV and computer monitors, intelligent systems, etc. These are critical developmental items used in military systems as well as in civilian commercial products.

A97-003 TITLE: Parametric Difference Waves for Low Frequency Acoustic Propagation

KEY TECHNOLOGY AREA: Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop an advanced weapon that uses acoustical waves as an energy source. This acoustical source concept utilizes parametric difference waves to generate high frequency acoustic energy, as the carrier, and a low frequency response at the target.

DESCRIPTION: The creation of parametric difference waves to generate a high frequency carrier and a low frequency response at the target, can be achieved by utilizing multiple sources. An array of sources operated with an off-set in frequency will produce low frequency acoustic energy at/near the target. This is desirable due to the fact that high frequency is highly directional, but is attenuated by the atmosphere, whereas low frequency is omni-directional but it propagates very well with very little absorption/attenuation due to its long wavelength. The intent of this effort is to design, fabricate, and test an acoustic source with a resulting acoustic beam which will have the following characteristics: a) directionality associated with the high frequency component, and b) the range of propagation (attenuation) associated with the low frequency component. Ultimately, this type of technology would be useful for applications to future man-portable small arms weapon systems requiring lethal potential.

PHASE I: Create and deliver designs and initial experimental results/data utilizing off-the-shelf components, which demonstrate the proof-of-principle. These experiments should be performed in the laboratory with laboratory type devices and off- the-shelf components.

PHASE II: Develop, construct, test, and deliver one or more working prototype acoustic sources. In addition, Phase II should include a plan-for technology maturation which would lead to a fully developed, man-portable weapon system. This system should be consistent with other small arms requirements, i.e. total system weight should be within the range of 3-20 pounds.

PHASE III DUAL USE APPLICATIONS: Law Enforcement applications include crowd control, prison control, officer protection, and sniper situations. Military applications include a wide range of lethal and non-lethal infantry applications.

A97-004 TITLE: Application of Artificial Intelligence and Pattern Recognition (AI/PR) Technologies to Convert Rasterized Drawings to Vectorized Drawings

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Demonstrate the application of AI/PR technologies to convert Computer and Logistic Support (CALS) Type I raster files of mechanical drawings to an industry-standard vector file format. DESCRIPTION: Most of the Services, and much of industry's existing technical drawing data, generally called "legacy data", have been digitally scanned and are maintained as raster drawing files. The data interchange standard adopted by DoD's Continuous Acquisition and Life Cycle Support program for digitized files is the International Telecommunications Union Group 4, Type I, Compressed Digital Raster Standard. Raster drawing files enable the exchange of technical data, but their large size consumes electronic storage space and network capacity, and they usually suffer from poor image quality. According to the Cleveland Electronic Commerce Shared Resource Center, these limitations pose serious impediments to electronic commerce. There are a wide range of commercial products available to manipulate raster files and to convert raster files to more useful formats (e.g., textual or vector). However, these products cannot discriminate between textual, vector, and symbolic entities, spacially relate them, and associate textual (i.e., dimensions) and symbolic entities with vector entities. The Automated Document Conversion System is a high- end example of such products. Software solutions to this problem must employ advanced AI/PR technologies that are narrowly tailored to the application, such as the Advanced Schematic Capture Automation, Navy (ASCAN) tool developed for the Navy's Rapid Acquisition of Manufactured Parts Program and the Army's Mechanical Engineering Data Capture System for integrated circuit board artwork. The need exists for a robust conversion software tool which is able to recognize and associate the various types of rasterized drawing entities found in mechanical drawings, and generate an exportable vector file compatible with existing commercial Computer-Aided Design (CAD) products (e.g., Auto CAD, Microstation, Corel CAD, etc.). These files would have the potential

to allow further processing to convert the vector file to a solid file format. Such a tool would extract value from, and extend the usefulness of, our existing legacy data, as well as decrease maintenance cost.

PHASE I: The contractor shall apply state-of-the-art AI/PR technologies with commercial off-the-shelf products to develop a software tool capable of converting CALS raster files of mechanical drawings to vector files. The tool shall be fault-tolerant to the extent that an unrecognizable pixel locus shall not cause a fatal error but shall be represented by a default entity. Batch preprocessing of the file to remove image noise (e.g., speckle) is permissible. The tool shall recognize, parameterize, and spacially locate (a) straight lines and circular lines having differing weights, (b) alphanumeric strings, including plus/minus and degree symbols, and (c) dimension and label elements, including witness lines with terminators. The drawing practices provided by ANSI Y14.5M-1982 (reaffirmed 1988) shall be used to the extent practical. The tool shall faithfully replicate the drawing information, but not necessarily generate an exact reproduction. The intent is not to develop an AI/PR engine, but to interface an existing engines available from, for example, Carnegie Mellon University or the University of Pennsylvania with commercial CAD and other products. Further, to the extent feasible, the tool shall be hosted on a PC without a hardware accelerator to assure reasonable access by small businesses. The contractor shall demonstrate the tool and shall submit a report that documents the solution used and the results obtained, define the computing environment and the software configuration.

PHASE II: The performance of the tool demonstrated during Phase I shall be improved to enhance its ability (a) to reliably translate a CALS raster file to a usable vector file, (b) to recognize continuation of intermittent lines, and (c) to recognize incomplete images of alphanumeric characters and geometric symbols. The functionality of the tool shall be expanded (a) to recognize line style (solid, dashed, centerline, etc.); (b) to recognize, parameterize and spacially locate cross- hatched areas; (c) to associate the dimensional element with the numeric parameter of the related geometric entity; and (d) to recognize additional symbols as defined by ANSI Y14.5M. The contractor shall demonstrate and deliver one copy of the tool with operating instructions, and shall submit a report that documents the solution used and the results obtained, and define the computing environment and the software configuration.

PHASE III DUAL USE APPLICATIONS: The burden of maintaining legacy data is common throughout the DoD and the defense, industrial, and commercial sectors. The software tool developed here would be an economically attractive alternative to manual redraws or the time- consuming rework associated with existing tools.

U.S. Army Research Laboratory (ARL)

A97-005 TITLE: Advanced Active Noise Reduction for Improving Speech Intelligibility in High Noise Level Environments

KEY TECHNOLOGY AREA: Manpower, Personnel and Training

OBJECTIVE: To develop Active Noise Reduction (ANR) that incorporates new technology above that presently in use by both industry and the military.

DESCRIPTION: The Army Research Laboratory has experienced success with the fielding of the new Vehicle Intercommunication System that incorporates ANR in high vehicle noise environments. This new communication system has dramatically improved both speech intelligibility and hearing conservation. It is desirable to further examine this area to improve the overall, absolute and perceived, noise reduction for various noise fields and spectral distributions. The focus of recent developments has been primarily with improving speech intelligibility in high noise environments, thus improving operator performance. With continuing focus on speech intelligibility, the new technology should also address issues involving optimization of psychoacoustics, comfort, and operator mobility. Methodologies that might be explored for increasing noise reduction capabilities are microphone and earphone location, use of multiple sensors, and the use of advanced predictive techniques. It is desirable for this technology to be applicable to both (1) a system for incorporation into a circumaural, passive hearing protector with communication capabilities at high noise levels (115 dBA) such as a tanker's headset; and (2) an open-ear system, with and without electronic communication capabilities, so a soldier can hear sounds and voices in a moderate noise environment (85 dBA) such as a truck or a command post shelter.

PHASE I: Phase I efforts must show proof-of-concept. Specific methodologies for improving the current state-of-the-art ANR systems shall be investigated, and the potential of each methodology, for use in the specific application, shall be described. Evaluation metrics include active versus passive loudness reductions, stability, ANR bandwidth, robustness, ease of use, user acceptance, speech intelligibility, and cost. Preliminary attenuation data should be obtained using military sounds such as Bradley Fighting Vehicle noise (for the circumaural hearing protector) and shelter and truck noise (for the open-ear system). The contractor shall demonstrate the two system concepts at the end of the contract period.

PHASE II: Phase II shall focus on optimization and design of the systems. For the open-ear system, optimization needs to be obtained between noise attenuation and through-the-air speech communications. Attenuation testing shall be conducted to measure the active and passive noise reduction. Human testing shall be conducted to demonstrate the speech intelligibility capabilities, the reduction in perceived operator workload, and the improvement in task performance in the various noise conditions. The contractor will demonstrate working versions of the systems at the end of the contract period.

PHASE III DUAL USE APPLICATIONS: Improvements in personal ANR systems are expected to expand the current commercial market. They will increase hearing protection and speech intelligibility to benefit pilots, earth moving equipment operators, and construction workers. Also, in the home market, the advanced ANR technology can protect individuals from hearing losses while operating power tools and lawnmowers. Personal ANR devices can benefit individuals performing any task in which moderate to high noise levels are present.

A97-006 TITLE: Natural Speech Processing for Virtual Environments

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To obtain a speech processing software system that will integrate with the ARL Natural Language and Virtual Reality system.

DESCRIPTION: Required is a full scale, large vocabulary, and large grammar continuous speech software system runnable on UNIX platforms, including the Sun SPARC and SGI workstations conforming to the following requirements:
1. The speech software must be useful with the ARL general coverage GB grammars, lexicons, and parsers. See the following references:

L. Haegeman, Introduction to Government & Binding Theory, 2nd Edition, Blackwell, 1994; V.J. Cook and M. Newson, Chomsky's Universal Grammar, 2nd Edition, Blackwell, 1996; B. J. Dorr, D. Lin, J. Lee, and S. Sungki, "Efficient Parsing for Korean and English: A Parameterized Message-Passing Approach," in Computational Linguistics, volume 21, 1995; J. Gurney, E. Klipple, and C. Voss, "Talking about What We Think We See: Natural Language Processing for a Real-Time Virtual Environment", Proceedings of the IEEE International Joint Symposia on Intelligence and Systems, Washington, DC, 1996.

The lexical and grammatical capabilities of the ARL natural language processing software should (if possible) not be compromised by limitations of speech processing.
2. In addition to 1, above, goals for the project must include efficient and accurate processing of continuous speech with speaker- independent recognition with the lowest error rate and greatest capture possible.

3. Another goal must be good performance in environments of various kinds of noise.
4. Fast processing times (useful for human/machine interaction) must be achievable when running on Sun SPARC stations. Other processors may be recommended in addition for ARL consideration.
5. The recognition of natural language prosody should also be considered and demonstrated.
6. All source code must be available to Government researchers, developers, and programmers.

Standards of good modular programming should be used so that any part of the system can be easily modified by knowledgeable programmers and researchers at ARL.
7. The following intended uses of this software should be emphasized:
   a. creation of natural language interfaces to automated systems including but not limited to map-based decision aids and virtual reality systems;
   b. a tool for researchers in speech processing and natural language understanding.
8. ARL will also consider proposed enhancements to the above specifications.

PHASE I: Conduct a thorough study of the current state-of-the- art in the above items of interest; determine what technologies and software are available for use as is or as modified. Specify and recommend the final product to be developed in Phase II. Throughout Phase I there will be consultation with designated Government people.

PHASE II: Delivery of complete software system. Demonstration of performance on Government platforms by contractor people working with Government people, documentation appropriate to above-mentioned applications.

PHASE III DUAL USE APPLICATIONS: Dual-use technology applications include hands-free/eyes-free human computer interaction, telephonic applications, as well as a development tool for Original Equipment Manufacture (OEMs).

A97-007 TITLE: Materials or Surface Applications -Treatments for Control of Non-ionizing Electromagnetic (EM) Radiation

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Investigate novel and unique approaches to control EM environments using advanced materials or material coatings and applications.

DESCRIPTION: The Army has wide and varied concerns in controlling EM environments that arise from complex EM systems. EM environments from existing and emerging weapons systems create the potential for collateral effects on friendly forces. Power generation/conditioning/storage create complex interference and compatibility issues. Electromagnetic sensing/detection/and avoidance systems require control of EM emissions for survivability. Increasing use of composite materials in Army systems is offsetting the shielding and control provided by metal elements.

The DoD is interested in novel and innovative approaches to the control of non-ionizing EM radiation that could include advanced materials and/or surface treatments/applications to absorb and/or provide controlled reradiation of EM energy. Methods might include surface corrugation techniques and frequency selective surfaces. Materials could include dichromic and/or anisotropic materials including the nonlinear metal oxides. Engineered materials which include chiral media might prove useful. Combinations of such techniques including "sandwiches" of such materials could provide very unique capabilities. Frequencies of interest range from the very low frequency wave of magnetic character to the very high frequency range at 10's of gigahertz. Techniques that provide a "broadband" performance characteristic are highly desirable.

PHASE I: This portion of the effort will focus on defining and developing the concept(s) to the point of demonstrating feasibility. For this purpose, analysis or numerical demonstration would be acceptable, or measurements on samples that support the demonstration of concept are acceptable. The scientific and technical basis of the concept must be documented along with any limitations that are known.

PHASE II: Develop the concept into a realizable, implementable product. Obtain quantities of material sufficient for detailed characterization via testing and measurement. Consider and define the requirements for production and application of the materials/techniques for realistic demonstrations of capabilities.

PHASE III DUAL USE APPLICATIONS: EM compatibility and EM interference control in commercial industries such as telecommunications, computer products and entertainment electronics.

A97-008 TITLE: Computer-Aided Testing for Reusable Ada Software Components

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: To develop a theory and method for reducing the amount of testing required for reusable Ada software components through the use of test results obtained prior to storage in the reuse repository.

DESCRIPTION: Research is solicited on the problem of testing reusable Ada software components when they are retrieved from a reuse repository. Reusable components are usually tested before storage in a reuse repository. When a component is retrieved, if it is not used precisely for its original intent, then it should be fully tested after retrieval to guarantee safety and security of the target software. It should be possible to eliminate a significant part of this post-retrieval testing requirement if the results of earlier tests conducted on the component are stored and used in the later tests. If during the current test, an internal state is reached that is similar to one stored from an earlier test, then the remainder of the test may be eliminated.

PHASE I: Efforts should focus on development of general theory for computer-aided testing of reusable Ada software components, focusing on reduction strategies using stored test results to reduce the testing burden.

PHASE II: Efforts should focus on development of a prototype system for computer-aided testing of reusable Ada software components using the methods developed in Phase I.

PHASE III DUAL USE APPLICATIONS: This technology is applicable to all software testing activities, as well as software reuse activities. Many large corporations have been investing in the creation of large domain specific software architectures. These architectures contain reusable components that must be tested before inclusion in a new software product. This project has the potential to increase quality and reduce testing costs in these commercial systems.

A97-009 TITLE: Autofocus for Near Field UWB (Ultra-Wide-Bandwidth) Synthetic Aperture Radar (SAR) Data

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: ARL is interested in proposals that would solve the automatic/autonomous motion-compensation problem on near-field UWB SAR data without requiring any special targets or a priori knowledge of the scene developing, for example, a computationally efficient, low- latency algorithm to determine motion errors from a set of data.

DESCRIPTION: Many modern systems are based on image formation from
projection-slice data. Such systems include sonograms, MRI (magnetic resonance imaging), acoustic weld inspection systems, and SAR (synthetic aperture radar). Ultra-wideband (UWB) SAR is useful for detecting and locating buried targets and targets concealed by foliage and camouflage. However, the low frequencies used to penetrate the obscuring media force one to use

extremely long apertures because long apertures are required to obtain high cross-range resolution. These long apertures are collected by small undulating aircraft. Therefore, the image formation algorithm must operate in the near field on data that is collected with uneven spacing on a non-straight line. Image formation can be accomplished for such apertures when the motion is known. However, motion sensors on many data collection platforms do not provide adequate accuracy for performing high-resolution imaging.

Current state-of-the-art autofocus algorithms assume that simply time- shifting (range correcting) each radar pulse will correct the data. However, this assumption fails with near-field data. In near-field data, given a particular position error, a target in one part of the scene may need to be moved closer while a target in another part of the scene may need to be moved farther out.

Three surveyed calibration reflectors have been used to solve for the (x, y, z) position of the radar sensor on each pulse to show that image formation can be done correctly for all pixels using data derived motion measurements. However, this technique is not feasible for live operations. Furthermore, data-storage limitations require that the algorithm obtain motion measurement estimates with minimal latency. In other words, the sensor position for pulse N must be computed and available at pulse N+L, where L must be minimized.

PHASE I: Develop an algorithm that solves for the motion errors with low-latency. Show the performance of the algorithm as a function of L, the swath length of the data, the antenna beamwidth, the average aircraft velocity, the dynamics of the aircraft, and the signal-to-clutter/noise ratio.

PHASE II: Code an optimized algorithm to run in real-time on a real-time image formation processor. Demonstrate typical 1.5 KHz repetition rates, 50-200m/s aircraft velocities, and 256K point records can be processed in real time.

PHASE III DUAL USE APPLICATIONS: In addition to concealed target detection, commercial applications include such services as bald earth mapping for road and construction planning, forest characterization, finding near-surface mineral deposits, locating downed aircraft, and humanitarian unexploded ordnance clean up. The worldwide unexploded ordnance clean-up market has been estimated at several trillion dollars. The major obstacle to 3D GPR image formation is the poor positional information of the radar sensor. Successful development of a data-derived measurement system could open-up these markets by allowing the routine production of high-resolution imagery.

A97-010 TITLE: Flexible Membrane Material for Acoustic Signal Management

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop a drapable material possessing both structural flexibility and the capacity to actively modify the signature characteristics of undesirable noise sources.

DESCRIPTION: Signature management in the field is increasingly crucial in an effort to develop effective means of defeating or minimizing hostile threats and detection. This noise may be generated from a variety of sources, including portable generators, pumps, vehicles, and troop support equipment. The currently available noise canceling or noise attenuating technology suffers from a lack of flexibility in its deployment, as well as requiring a high (and costly) degree of specialization depending on its application.

PHASE I: Identify and develop combinations of materials that may be used to fabricate a membrane that could be readily applied to a particularly noisy piece of equipment. For example, this novel material may be placed around or on the undesirable noise source and subsequently "tuned" to either cancel the noise or shift its signature to mitigate its true nature. The material may be composed of organic and inorganic materials (e.g., polymers, ceramics, piezoelectrics) with the emphasis on developing a flexible, fabric-like specimen. Demonstrate the specimen's ability to generate both noise and noise canceling sound waves. Deliver a working specimen together with a characterization of the specimen under various operating conditions.

PHASE II: Exploit the success of Phase I with particular emphasis on a full-scale demonstration of the acoustic management material applied to an Army-specified piece of equipment or application. Prototype and deliver a "turn key" system and an amount of material for intensive Army evaluation. Generate database and supporting technical information that will aid in assessing, deploying, and producing the material. Investigate scale-up and manufacturing issues for the economic and effective fabrication of the acoustic signature management material.

A97-011 TITLE: Novel Materials/Materials Structures Development for Thermoelectric Device Applications

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop, characterize and demonstrate novel materials/materials structures with improved thermoelectric properties for use in cryogenic cooling systems and refrigeration and thermoelectric power generation. The development of this technology will support current and future Army man-portable systems by reducing power consumption, cost and weight while increasing reliability and life cycles.

DESCRIPTION: Some materials of interest under this program are superlattice quantum wells, quantum wires, synthesis of fine grained powders and films, rare earth, ternary and quaternary materials, low thermal conductivity skutterudites, and materials exhibiting unusual transport properties. The goal for this development effort is to achieve a cryogenic temperature of 77K with at least a 1% coefficient of performance (COP) using a multistage thermoelectric cooler. The figure of merit (FOM) of the material ZT, where $Z = s^2/pk$ (s = Seebeck coefficient, p = electrical resistivity, k = thermal conductivity, T = temperature in Kelvin) must exceed 1 over the entire temperature range (current state-of-the-art is equal to or less than 1). It is a goal for the material to have a ZT of over 3 as an average from 77K to 300K. Advantages of thermoelectric solid state cooling are compactness, quietness, reliability, no moving parts, localized cooling or heating, and temperature stabilization.

PHASE I: Investigate novel materials/materials structures for the purpose of developing advanced thermoelectric materials with a ZT of approximately 3.

PHASE II: Development and characterization of novel materials/materials structures and implement into a prototype system for test and evaluation.

PHASE III DUAL USE APPLICATIONS: Dual-use applications include refrigeration, air conditioning, portable man climate systems, cooling of CCDs, infrared detectors, low noise amplifiers, rapid cooling and temperature control of integrated circuits and electronic components, and as an environmentally benign alternative to chlorofluorocarbons.

A97-012 TITLE: High Temperature Dielectrics

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Investigate dielectrics to be used as gate insulators and high field passivation for high-temperature, high-power electronics and produce prototype devices in silicon carbide (SiC) technology.

DESCRIPTION: Tank-Automotive and Armaments Command (TACOM) has been pursuing high-temperature electronics for vehicle applications; which include vehicle propulsion, active protection, electric gun, and turret control. TACOM Research, Development, and Engineering Center (TARDEC) completed an exhaustive design study on an electric drive technology demonstrator (EDTD) in 1994 for the future main battle tank, and currently has three ongoing hardware demonstrator programs. In the EDTD study, SiC was identified as a critical electronic technology for use in future armored vehicles. TARDEC recently closed a two-year contract with General Electric (GE) for the development of SiC power transistors to support their propulsion applications. GE, through this contract, was able to solve many critical processing problems but were unable to fabricate power devices which conducted the design current due to problems with epitaxial layers and high- temperature high-field dielectrics that were used, including silicon dioxide (SiO2) which was used as the gate insulator. To date, no group has reported SiC high-field oxides such that the full benefit of the high-temperature operation of SiC can be achieved. Alternative dielectrics must be developed for high-temperature and high-field insulators and passivations for SiC devices.

PHASE I: Investigate alternative dielectrics for high- temperature, high-field applications and produce test structures such as metal-insulator-semiconductor (MIS) capacitors and diodes in SiC which show the dielectric's applicability is superior over that of silicon dioxide for device operation at 350□C.

PHASE II: Fabricate MIS field-effect transistors using the alternative dielectrics down-selected in Phase I.

PHASE III DUAL USE APPLICATIONS: The market share for high- temperature electronics is projected to be in excess of one billion dollars by 2005. The dielectric technologies that are to be investigated through this SBIR are key to the development of high- temperature electronics for the marketplace. General Electric and Northrop-Grumman have been actively pursuing SiC device fabrication technology for automotive and avionics applications.

A97-013 TITLE: Processing of Nanomaterials for Lightweight Armor Applications

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop nanomaterials processing techniques to provide fully dense nanomaterials or nanocomposites that provide increased protection at greatly reduced weights.

DESCRIPTION: Nanomaterials provide a unique opportunity for armor as the properties of nanomaterials are projected to be vastly improved over those of traditional bulk materials. These property improvements have already been demonstrated for hardness, a property known to influence the performance of armor materials. Nanomaterials have grain sizes that are less than 100 nanometers. In this range the disordered grain boundaries account for a significant fraction of the volume of the structure. The grain boundaries are of a lower density than the bulk crystalline structure and can result in an overall density reduction of up to 10%. Lightweight materials are the future in armor materials and systems development. These materials may be used in applications or systems that require weight reduction or would improve in performance as a result of lighter weight. Examples are in personnel armor where enhanced protection could be had with little or no increase in weight. Other examples are for vehicles that cannot afford significant weight increase but require enhanced protection.

PHASE I: Identify and develop materials and advanced processing methods for the fabrication and production lightweight armor materials or systems of materials. The applications may range from personnel protection to armor for ground vehicles, helicopters or other niche armor uses. The methods developed should be readily adaptable to production environments. Demonstrate the appropriateness of the materials and processing methods for the application(s). Deliver demonstration components produced with the materials, techniques, methods or procedures developed. Develop or apply testing methods that adequately demonstrate the advantages of the materials and processes developed.

PHASE II: Work in Phase II should exploit the Phase I success, expand the range of materials and processes and begin to apply the methods developed to production-like situations. This work should highlight the generic nature of the developed material, process or method and deliver prototype or demonstration components. If appropriate, a prototype of equipment developed should be delivered. Testing in Phase II should be suitable to demonstrate the benefits of the material or process developed.

PHASE III DUAL USE APPLICATIONS: Developments in the processing of nanocrystalline ceramic materials will have immediate application in all areas of ceramic materials. The nanocrystalline materials offer the opportunity to raise the mechanical and physical properties of these materials to provide improved structural components. Ceramic armor will have

application in numerous military systems and will find uses in police enforcement. Other spin-off opportunities exist in that ceramic materials

A97-014 TITLE: Rapid-Multiplexed Laser Initiator

KEY TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Design and build a compact, rugged device with 20 fiber- optic coupled outputs from a single laser.

DESCRIPTION: Laser ignition of simulation and training pyrotechnic devices require an initiation source which is a compact, man-portable, rugged package which contains a single laser and 20 fiber-coupled light output ports. The output ports can be activated in random sequence upon command and with time intervals from 200 millisecond (0.2 second) to several minutes. A maximum of six ports would be activated in any three-minute time interval. The energy output of each port should be sufficient to provide a minimum of 200 millijoules (0.2 joule) of energy through a 400 micron fiber optic mounted in the port. The devices coupled into the ports will be single-use and the cost of the optical components must be minimized. The use of low-cost fiber optics, including plastic fibers or non-connectorized fibers should be evaluated. Options for self-contained and external power should be evaluated.

PHASE I: Design, build, and deliver to the government a working prototype with 20 outputs and energy requirements as specified.

PHASE II: Improve the prototype system to ruggedize fully, to increase rate of light output to full requirement, and to optimize fiber-optical coupling efficiency. Explore the use of low-cost fibers and connectors.

PHASE III DUAL USE APPLICATIONS: In addition to laser initiation of pyrotechnic simulators and other DoD mission-related applications such as igniting ordnance for rocket launch vehicle applications, the use of multiplexed lasers has potential for industrial applications where lasers are used for machining, marking, and trimming. The application of multiplexing would enhance the utility and decrease the effectiveness of industrial systems.

A97-015 TITLE: Affordable Transmit/Receive Modules for Millimeter Wave Electronic Scanning Antenna Technology

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: The Army has an inherent need to develop enabling radar technology that is both affordable and flexible, with growth potential to address new radar requirements. An area that best demonstrates a need for both affordable and flexible technology is the antenna assembly process. Transmit and Receive (T/R) modules are used in electronic scanning antennas (ESAs) for distributing power across an aperture in transmit mode and setting the noise figure across the aperture in receive mode. In all cases, a phase shift/time delay control element is added for beam steering and an attenuator is used for beam shaping and to reduce sidelobes. For many antenna technologies, the T/R module drives the cost for the antenna architecture and limits its performance. We are looking for T/R modules to populate a low-cost two-dimensional aperture. The T/R module designs should operate at a center frequency between 33 and 35 GHz, with a technology growth potential to operate at higher frequencies (i.e. the W Band), a 2 GHz bandwidth, compression capability of several Watts per module, a maximum noise figure of less than 3 dB, and losses of less than 2 dB. A scan capability of + 30□ at a 60□/sec scan speed and a scan width that does not change with frequency should be produced through phase shifting or time delay techniques. Amplitude control should be capable of producing sidelobe levels that are greater than 20 dB. Switching speeds between the transmit and receive modes should be less than 500ns.

DESCRIPTION: An antenna is required to support the various missions associated with a target acquisition radar. These missions include moving and stationary target indication (which suggest low antenna losses), a modest gain, a narrow beam, wideband operation, and polarimetrics. The T/R module is the key component for developing such an antenna architecture.

PHASE I: This effort should study the novel T/R technologies that can support the above specifications, emphasizing technology tradeoffs with respect to affordable and flexible architectures. There should be considerable reasoning in the selection of a T/R module over another. Identify areas of risk associated with the chosen architecture. Simulate and develop a preliminary design and describe the flexible features and the upgrade path for this module. There should also be a cost breakdown for prototyping a two-dimensional aperture array with a suitable number of elements to meet the above objectives.

PHASE II: Simulate, design, build, test, and report on the chosen T/R module design from the Phase I effort.

PHASE III DUAL USE APPLICATIONS: T/R modules that are both affordable and flexible, and are associated with supporting radar technology, may have vast commercial opportunities (i.e. collision avoidance in the automobile industry).

A97-016 TITLE: Multipurpose Personal Radio-Communication System

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To develop a non-intrusive personal communication system for individual soldiers that allows the user to receive and send both acoustic and radio information in various military environments, including high noise-level conditions, urban warfare, and special operations assignments. The user should be able to process multichannel radio communications, interpret Global Positioning System (GPS) data, and receive tactical instructions and acquire enemy surveillance data using the device.

DESCRIPTION: The Army Research Laboratory has demonstrated that three- dimensional Auditory Display (3D Audio) systems greatly improve multichannel communication in noisy environments and provide enhanced navigation capabilities for both mounted and dismounted soldiers. The desire is to combine this technology with radio-communication system and package the device as a small, lightweight, energy efficient, and battery-operated unit to be used in conjunction with non-obtrusive earphones or in-the-ear receivers. The developed system requires binaural capability to facilitate 3D Audio. In addition, the system should address such issues as mobility and comfort of the user, inconspicuous wearing, long-term usage, hearing loss of the user, need for enhancement of noise-degraded speech, and need for directional enhancement of the user's hearing. The system should integrate seamlessly with existing communication systems and be also usable in a stand-alone mode. Additional capabilities such as Active Noise Reduction (ANR) and continuous GPS data reception should be considered.

PHASE I: Perform a system engineering study to define the most efficient, reliable, and cost-effective approach(es) toward the development of a personal radio-communication and listening system that provides data and voice transmission including 3D Audio capabilities. Potential commercial applications shall be included in the Phase I definition.

PHASE II: During Phase II, a fully functional prototype will be developed. Performance of the system shall be demonstrated in the laboratory and in the field under specific military conditions. The system will be analyzed in a stand-alone mode and in conjunction with existing communication systems. The requirements of system customization for specific applications within the military community shall be addressed as will the cost of miniaturizing the system for in-the-ear and pocket implementation.

A97-017 TITLE: Monitoring of Soldier Load Muscle Fatigue

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Develop a remote surface electromyographic (EMG) sensor system to monitor local fatigue in individuals performing normal soldiering activities.

DESCRIPTION: Localized muscle fatigue limits the ability of the dismounted soldier to execute mission related tasks. Since at least 1971, it has been known that electromyography (EMG) can be used as a non-invasive indicator of local muscle fatigue. Fatigue is indicated by a shift in the EMG power spectrum from high to low frequencies. The reasons for this are complex but are at least partly due to a decline in the conduction velocity of muscle fibers. More recent developments also allow calculation of the remaining performance capability of the muscle group. One problem in using this technique outside the laboratory has been the fact that subjects needed to be hardwired and thus closely tethered to the measuring instrument. However, developments in portable telemetry may allow soldiers to perform normal functions with a minimum of interference while EMG are being monitored from remote sites.

PHASE I: Design a remote (telemetry) surface EMG sensor system for detecting and quantifying localized muscle fatigue in soldiers. Quantify the reliability of the system. Assess the feasibility of the system to predict fatigue while soldiers are performing normal soldiering tasks such as walking with rucksacks, climbing over obstacles, crawling under objects, etc.

PHASE II: Develop, test, and operationally demonstrate the Phase I concepts using actual hardware and data in a prototype system.

PHASE III DUAL USE APPLICATIONS: A remote EMG sensor system would allow producers of consumer goods to fashion items in a more ergonomically sound manner since goods could be designed to minimize local fatigue. Medical applications include the monitoring and evaluation of patients during rehabilitation.

A97-018 TITLE: Small Arms Shooting Accuracy Measurement System

KEY TECHNOLOGY AREA: Manpower, Personnel and Training

OBJECTIVE: To develop diagnostic instruments and techniques to (a) monitor shooter target acquisition, tracking, final aim, and firing and related performance in real-time, and record for subsequent analysis; and (b) provide real-time feedback to the shooter.

DESCRIPTION: Despite the importance of shooter performance to the Army, little diagnostic data are available which would allow detailed understanding and perhaps improvement of critical facets of that performance. There is a need for a means to analyze tracking and firing performance down to milliseconds in order to evaluate the effects of recoil, recoil anticipation, body sway, body tremor, trigger pull tension, flinching, etc., on aiming and shooting performance. In addition, it is necessary to provide the shooter with near real-time feedback of single- and burst-shot accuracy performance. The system must be able to track performance to targets out to 300 meters, near-term, and 500 meters, long-term (within 2 years). Any gun-mounted electronics must withstand up to 10 ft/sec force and must add minimal weight, no disruption of hand hold, and must not disturb the perceived center-of-gravity of the weapon. Data generated must be compatible with standard PC databases. Any analytical software must be provided in both compiled and comparable form; preference is for programming in C++.

PHASE I: Design a shooter tracking, aiming, and firing performance recording and measuring device as described above. Assess the feasibility (in terms of durability, maintaining boresight, low weight, unobtrusive placement) of mounting the necessary hardware on a military rifle. The system is to be implemented at the ARL-HRED instrumented firing range at APG, MD. The range has four firing lanes, with target distances from 50- 550 meters; life-size targets are computer-controlled to pop up or down in a variety of experimenter-directed scenarios; shooting may be examined from standing, kneeling, prone, or foxhole positions, each of which must be supported by this diagnostic system.

PHASE II: Develop, test, and operationally demonstrate Phase I concepts using actual hardware and data in a prototype system.

PHASE III DUAL USE APPLICATIONS: Diagnostic data on small arms shooter activity would permit true performance-based guidance for (a) reducing training time for shooters from military, law enforcement and recreational areas, both for existing and emerging weapons; and (b) improve weapons by identifying which design features enhance or inhibit various facets of shooter performance.

A97-019 TITLE: Survivability Technology Analysis Tool

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Support tradeoff studies and Quality Functional Description (QFD) decision processes associated with the identification of survivability technologies considered for application to ground vehicles.

DESCRIPTION: A Survivability Technology Analysis Tool is needed to enable engineers to identify and understand the system, subsystem, and component-level issues associated with achieving user-specified levels of performance in all survivability technologies. This analytical tool will identify critical parameters associated with the achievement of a given level of performance in each survivability domain, establish functional linkages among relevant survivability technologies, identify, relate the impact of changing performance in one technology to other technologies of interest, and identify system burdens imposed by candidate survivability technologies. This tool will support decision processes and tradeoff assessments throughout the Army's engineering and analytical communities and improve the efficiency of the QFD processes currently used by the ground vehicle community in the development of the next generation of combat vehicles. Since this model is process-driven, the methodology developed under this SBIR will also support QFD processes implemented by commercial manufacturers.

PHASE I: This effort will establish the feasibility of the model. Emphasis will be on development of user-defined performance relationships and parameters, establishing the appropriate functional linkages, developing an expert system architecture, and designing the model architecture.

PHASE II: This effort will implement the model structure defined in Phase I, demonstrate the model's ability to support tradeoff studies and QFD efforts, and define a QFD-supported tool that will conform to the needs of a Government-designated commercial market.

PHASE III DUAL USE POTENTIAL: Will implement the analysis tool to support QFD efforts in a Government-designated commercial industry. The QFD process is currently recognized as a means of ensuring early identification and resolution of system design issues. This process is well-established in defense and commercial industries; however, the process is still manpower-intensive. Development of an analysis tool such as this will provide a means of automating the QFD process throughout industry.

A97-020 TITLE: Development of Modular Vehicle Concepts for Scout, Robotic, Light, and Heavy Combat Vehicles

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Develop and propose new modular concepts for the future ground scout vehicle, including robotic concepts, and for the future medium (10T-15T) and heavy (15T-40T) ground combat vehicles. Evaluate and validate proposed concepts using available or modified simulation programs. For example, a concept of interest is for a robotic scout vehicle, as one element of an articulated modular vehicle that could disengage from the main vehicle, operate robotically, return and reconnect to the parent vehicle. Further objectives include the development of necessary methodologies and small scale model test procedures to predict mobility characteristics for new modular vehicle concepts.

DESCRIPTION: The proposed SBIR task seeks to conceptualize, design, and evaluate the mobility benefits of modular light, medium, and heavy combat vehicles given the perceived benefits of articulation. A mobility comparison is sought between this "caterpillar-like" modular vehicle and present combat vehicles. Subscale model testing is required to generate experimental data for evaluating and downselecting promising concepts.

Based on Army requirements for future combat vehicles, vehicle characteristics that influence rapid force deployment and battlefield mobility are of high priority interest. As unmanned ground vehicles move toward smaller size, mobility tends to decrease. The design requirement is to develop a concept with good mobility characteristics in combat terrain and obstacle conditions. The topic presented to evaluate the mobility characteristics of an articulated, modular, all- wheel-drive vehicle has evolved from discussions with TACOM Research, Development, and Engineering Center (TARDEC), COE (WES), United States Marine Corps (USMC), and ARL, and represents a proposal of mutual interest. The proposed concept features a modular light weight vehicle consisting of a "train" of "cars", each made up of a power source, crew, and armament modules. Each module would be capable of being transported in a cargo hold of a ship or plane allowing rapid force deployment. The modules can be quickly connected on site. Electric drive, used for tracks or wheels, would allow the vehicle to be joined via flexible couplings, resulting in articulated sections. Based on technological advancements in materials, electrical drive systems, and robotics, modules (ranging from 5 Tons to 15 Tons) can be designed with improved mobility and transportability.

PHASE I: New modular concepts will be developed based on the present and future technologies in robotics, electric drive and control systems, materials and tires for ground scout vehicles. Analytical tools will be developed in addition to existing simulation programs (such as the NRMM - NATO Reference Mobility Model) to predict mobility characteristics of new modular vehicle concepts. A plan for small-scale model testing of new concepts will be developed to generate experimental data on mobility and soil parameters. The data will be generated during the Phase II study using the Corps of Engineers (COE) Waterways Experiment Station (WES) facilities. Comparisons will be made, based on simulations, with similar tracked and wheeled conventional vehicles to select promising concepts for full-scale testing and evaluation in the second phase.

PHASE II: (A) Small-scale model testing of new concepts will be performed according to the plan developed in Phase I, preferably at WES facilities for various combat terrain and obstacle conditions. (B) Experimental data will be analyzed and used to upgrade simulation inputs. The predicted performance comparisons will be made with similar existing vehicles. (C) The down selection will be made for an optimum modular concept and will be tested in full-scale at the WES facility to determine mobility characteristics in different combat scenarios.

PHASE III DUAL USE APPLICATIONS: The new modular, robotic, electric device and control systems technologies can be used for commercial applications (heavy transport/ earth moving equipment) and over-the- road vehicles. New simulation programs developed here can be used to predict performance characteristics of modular vehicles for a particular commercial application.

A97-021 TITLE: Foil Bearing Stiffness and Damping Measurement System

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/GroundVehicles

OBJECTIVE: Develop technology for measuring foil bearing stiffness and damping characteristics across the range of turbomachinery operating conditions.

DESCRIPTION: The U. S. Army is interested in high-temperature, high- speed, high-load capacity advanced foil bearing technologies for primary bearing applications in vehicle propulsion system turbomachinery (diesel engine turbochargers and turbine engines). Properly designed foil bearings offer the potential to improve fuel efficiency, reduce weight, improve durability, and reduce operating costs for vehicles. Critical characteristics in the design of foil bearings for optimum performance in specific turbomachinery applications are bearing stiffness and damping across the operating range. This topic solicits innovative concepts for measuring foil bearing stiffness and damping characteristics for turbomachinery running at anticipated operating conditions of (100-1400□F and up to 100,000 rpm). Proposers shall identify their (and optional research team partners) relevant past experience, expertise, and existing facilities in the areas of high-temperature testing and compliant foil bearing turbomachinery. Proposals must identify and justify the critical technology barriers that must be overcome in the development of the proposed bearing stiffness and damping measurement technique.

PHASE I: Demonstrate (by experimentation) significant progress toward overcoming the critical technology barriers associated with the measurement technique. Plan a Phase II development.

PHASE II: Develop the measurement technique and refine to a robust prototype technology demonstration level across the foil bearing operating range.

PHASE III DUAL USE APPLICATIONS: The developed stiffness and damping measurement technology can be marketed as research and development equipment for foil bearing research and manufacturing organizations. The information resulting from application of the technology will yield improved foil bearing designs with significant new market potential in military and civil turbomachinery for propulsion, power generation, and other applications.

U.S. Army Research Office (ARO)

A97-022 TITLE: Film Processing Monitoring with Monolayer Control

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Demonstrate detection of monolayer-level sensitivity for non-crystalline films during deposition.

DESCRIPTION: Present-day methods of thin-film deposition use process- monitoring methods for control of the film thickness which measures the flux of material before it is deposited (e.g. Mass Spectrometry of gas-phase species). However, such present-day commercial methods do not directly detect the film thickness itself, and thus have control only of order 10-50 monolayers. Many new materials systems of importance to defense technologies utilize ultra-thin films which are of the same thickness as some of the uncertainties in present film monitoring methods. For crystalline films the use of electron diffraction in commercial systems can accomplish monolayer control but current needs are for systems that have monolayer control for polycrystalline or amorphous films. Thus both a military and commercial need exists for a simple routine method of monitoring films at the monolayer level which does not depend on the crystalline nature of the film growth. Recent advances in new optical methods such as scanning ellipsometry and polarized reflectance difference methods have shown promise of such a technique. These methods have been compared with electron diffraction methods to demonstrate monolayer sensitivity. Such optical methods have not yet been applied to non- crystalline film growth, but this application should be possible due to recent improved detector sensitivity. Other methods based on light scattering or other property signatures might also be utilized. Benefits would be improved film deposition and control for both military and commercial needs with increased efficiency and improved affordability. There are significant commercial applications of these techniques. Although private industry may develop such a device, they may incorporate such a device into a proprietary system which is not readily available for military applications.

PHASE I: Demonstrate detection of mono-layer sensitivity for non- crystalline films during depositions.

PHASE II: Using a prototype film-processing-sensor system, demonstrate real-time closed-loop control of films at the monolayer level for a variety of non-crystalline films in the thickness range of 10-10000 monolayers.

REFERENCES:

1. D. E. Aspnes, "Minimal-data approaches for determining outer- layer dielectric responses of films from kinetic reflectometric and ellipsometric measurements", J. Opt. Soc. Am., Vol. A10, pp. 974- 83 (1993).
2. P. B. Smith, "Spectroscopic ellipsometry as a real-time sensor for the fabrication of infrared photodiodes", Proc. SPIE-Int. Soc. Opt. Eng., Vol. 2228, pp. 324-31 (1994).

PHASE III DUAL USE APPLICATIONS: Commercial ability to increase efficiency and affordability of film process monitoring at the monolayer level. There are obvious commercial applications of these techniques; although private industry may incorporate such a device into a proprietary system for internal use.

A97-023 TITLE: Microfabricated Wall Shear Stress Transducers

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop, fabricate, and validate microfabricated turbulent wall shear-stress transducers robust enough to operate in the presence of freestream contaminants such as dust.

DESCRIPTION: A critical variable describing the fluid mechanic flow state over a given surface is the wall shear-stress. Unfortunately, the accurate measurement of wall shear-stress with adequate spatial and temporal resolution has been difficult to perform because of calibration difficulties, and because of the physical size of the instrumentation necessary. (See reference 1) Recently, wall shear- stress sensors have been fabricated using a microelectromechanical systems (MEMS) approach and have

shown great promise. Because of their small physical size and mass, MEMS-based shear-stress transducers offer superior spatial and temporal resolution. (See reference 2) Unfortunately, the application of these devices in real aerodynamic environments is hampered by their sensitivity to airborne contaminants, such as dust, rain, ice, insects, and dirt. This solicitation seeks innovative design and packaging approaches for MEMS- based sensors capable of accurate turbulent wall shear-stress measurements in real aerodynamic environments.

PHASE I: A design/feasibility study will be performed with particular emphasis on temporal and spatial accuracy, manufacturability, and resistance to environmental contaminants. Additionally, a detailed test plan for device validation will be formulated.

PHASE II: In Phase II the device designed in Phase I will be fabricated and validated in a variety of real-world aerodynamic environments.

PHASE III DUAL USE APPLICATIONS: Accurate, inexpensive, and environmentally-insensitive MEMS-based turbulent wall shear-stress transducers should find wide application throughout the aerospace industry. In addition, the packaging and manufacturing techniques developed under this solicitation will be of great commercial use for the production of other MEMS-based transducers and actuators for aerodynamic measurement and control.

REFERENCES

1. Harionidis, J. H., "The Measurement of Wall Shear-Stress, " In Advances in Fluid Mechanics Measurements, Lecture Notes in Engineering, Vol. 45, Springer-Verlag, 1989.
2. Mehregany, M., DeAnna, R.G., and Reshotko, E., "Microelectromechanical Systems for Aerodynamics Applications," AIAA paper, AIAA-96-0421, 1996.

A97-024 TITLE: Human Dynamics Modeling

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: Develop a detailed design for a human dynamics model that integrates mathematical formulation of realistic physics with dynamic simulation and interactive visualization.

DESCRIPTION: Human dynamics models can facilitate rapid evaluations and analysis of human-material interface issues such as those concerning clothing, footwear, backpacks, and other soldier's accessories. A combination of mathematical and simulation-based human dynamics models can significantly shorten the material acquisition cycle. Such models will also help to assess the forces experienced by the individual as a function of both the loads being carried and the individual's level of activity, e.g., walking, running, or climbing. The model could further predict the stresses and energy expenditure in the individual's bones and joints during task operations to examine various factors, such as comfort, physical performance, energy consumption, and stresses on the body joints.

Advances have been made in near real-time kinematics modeling of human articulation. There is still a need for physics-based models and biologically-inspired learning algorithms for human dynamics. They will enable the development of prototyping systems and provide the necessary analytical bases to ensure accurate, realistic portrayal of both the interaction of clothing and accessories with the individual combatant in distributed interactive simulation. This effort will also contribute to the development of robust human-centered synthetic environments to enhance analytic capabilities and promote rigorous analysis for evaluating alternative design concepts and quantifying human factors study. Human dynamics modeling will furnish enhanced technical knowledge in human biomechanics, ergonomics study, physiological performance, medical training, task simulation and anthropometry, as well as increasing operational effectiveness and improving soldier performance on digitized battlefields.

PHASE I: Develop a detailed design for a human dynamics model that integrates the mathematical formulation of realistic physics with dynamic simulation and interactive visualization and demonstrate in a preliminary implementation.

PHASE II: Implement the detailed design developed in Phase I and produce a working proof-of-concept system. Demonstrate the proof- of-concept system on an appropriate application domain which has the potential for dual-use or commercial exploitation.

PHASE III DUAL USE APPLICATIONS: Faster and more effective simulation and analytical tools developed for human dynamics modeling can enhance human performance, facilitate design decisions on clothing, footwear, and equipment at affordable costs, provide tools for ergonomics analysis and surgical simulations, and achieve risk reduction for Task Force XXI.

A97-025 TITLE: Novel Receiver Structures for Code Division Multiple Access Communications

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To research, design and demonstrate novel Code Division Multiple Access (CDMA) receiver structures that are tolerant to multi- access and multi-path interference.

DESCRIPTION: Code Division Multiple Access (CDMA) has the potential to use the limited electromagnetic spectrum more efficiently than either Frequency Division Multiple Access (FDMA) or Time Division Multiple Access (TDMA). However, the tight power control requirements necessary to overcome the near-far problem limit growth. Previous efforts at developing systems that are more tolerant of multiple-user environments have focused only on the base station in a cellular environment or the central node in a wireless Local Area Network (LAN). Novel receiver structures, utilizing techniques such as multi- user detection, are needed that overcome the near-far problem in a multipath environment while also operating within the power limits and hence reduced computing power of a vehicular-mounted unit.

PHASE I: Research and design novel CDMA receiver structures that reduce the power control constraints required by existing systems, such as IS-95, within the power and computing envelope of a vehicular-mounted unit.

PHASE II: Demonstrate proof-of-concept operation within a mobile wireless environment.

PHASE III DUAL USE APPLICATIONS: This technology can be directly applied to the burgeoning market for wireless local area networks, personal communications services, and cellular communications to increase the capacity of new and existing systems, as well as improve quality of service.

A97-026 TITLE: Antennas for Aerial and Ground Vehicles in Distributed Mobile Networks

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Investigate innovative antenna concepts for small, broadband antennas.

DESCRIPTION: Tactical data communications for future ground operations will require multi-band and multi-channel operation from tactical aerial and ground vehicles. Electromagnetic and survivability considerations will constrain the locations on the vehicle available for antenna mount and will severely constrain the size allowed for the antennas. At the same time, communications channel performance will become even more demanding for vehicles operating under marginal propagation conditions, such as in built-up areas and flying nap-of-the-earth. Innovative antenna concepts are needed for broadband antennas with small physical profiles but which maintain reasonable gain. Concepts for multifunctional or common aperture antennas, such as simultaneous multiple resonant frequency operation or switched multiband operation from the same antenna, are also sought. Innovative ideas for using parts of the vehicle structure itself for antenna functions are of interest. Frequencies of interest include HF through X-band. A successful SBIR proposal should address a coherent concept within these parameters. It is not necessary to address the entire frequency range, the entire family of aerial and ground vehicles, or the entire range of antenna functionality.

PHASE I: Demonstrate concept feasibility with experimental model or computer antenna model.

PHASE II: Demonstrate operation of the full-scale antenna structure and verify the antenna's performance under realistic field conditions.

PHASE III DUAL USE APPLICATIONS: The U.S. Army Materiel Command has expressed very specific interest in reducing the antenna signature of tactical vehicles. This represents a large potential market for commercial industry. There are over 4000 SINCGARS radios in a division, most of them requiring a vehicle mount. In addition to active duty divisions, there are reserve and national guard divisions. And there are sizeable potential foreign sales. The automotive industry has recognized interest on the consumer automotive market for low profile, multifunctional vehicular antennas. They are looking for ways of combining the antenna functions for wireless communications, PS, remote access, and AM/FM radio reception in a small number of flat, conformal antennas. These antenna functions correspond to the kind of antennas directly addressed in this SBIR topic. For the portion of the SBIR topic addressing tactical VHF and UHF frequencies there is not a direct consumer automotive interest, but since the antenna shapes remain the same, just scaled to size, the antenna designs in these frequency ranges are also of strong interest

A discussion with a communications planner for the North Carolina Emergency Management Center indicated that there has been a severe problem with the antennas of National Guard aircraft working with state emergency agencies in the field. Also National Guard vehicles supporting state emergency operations have major problems with antennas contacting downed power lines and restricting movement off- road through wooded areas. Solutions to these problems represent a good commercial opportunity for small business.

Antennas successfully produced under this topic would significantly improve mobile vehicular communications networks. In addition they can make possible mobile headquarters operations for fast moving police, rescue, forest fire fighting, or drug interdiction operations.

A97-027 TITLE: Communications Channel Propagation Modeling for Distributed Mobile Networks

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To develop an electromagnetic propagation model capable of characterizing a communications channel encountered between terrestrial vehicles during highly mobile operations.

DESCRIPTION: Highly mobile tactical operations require high capacity on-the-move data communications between terrestrial vehicles and helicopters engaged in rapid maneuver over extended distances. During operations in complex terrain such as urban or built-up areas, very steep mountains and hills, or dense foliage, communications links between ground vehicles or aircraft flying nap-of-the-earth stretch current communications technology to the limit. Commercial wireless systems typically rely on fixed-base stations with sophisticated equipment and high towers with many large antennas. These enable the commercial communications equipment in mobile civilian vehicles to be relatively simple and cheap. In contrast, mobile military systems have to operate on-the-move without fixed-base stations or fixed-tower facilities. These distributed mobile military networks will need sophisticated signal processing and smart antenna technology at each vehicular station in order to achieve the same level of performance as the corresponding civilian system. Optimization of these signal processing techniques, system concept evaluation, system design, system procurement specification and test, and operator training will require significant and detailed information about the physical propagation conditions in a deterministic, site-specific environment. Deterministic electromagnetic models are needed which can address signal propagation in complex terrain encountered by mobile military forces and which can characterize the communications channel between any two Army vehicles during mobile operations. As a result of movement of the vehicles, the nature of the communications channel will change rapidly. Such models need to address the effects of multipath reflections, diffractions, scattering, and waveguiding on signal coherence, path delay, polarization, and angular distribution. The proposed model should address a complex terrain condition and an applicable frequency range. For example, a bouncing ray model may apply primarily to propagation in urban terrain at UHF frequencies and above, or a parabolic equation model may apply to hilly terrain at VHF frequencies and below. Frequencies of Army interest range from the HF to X-bands. Proposals should address a coherent model within these parameters. It is not necessary to cover this entire range of frequencies, or more than one model type in the proposal. The proposed model should also address the issue of a realistic terrain database. The proposed model should be an advance on available state- of-the-art commercial sources.

PHASE I: Demonstrate feasibility of the algorithm for the solution of the electromagnetic propagation problem.

PHASE II: Develop a fully functional electromagnetic propagation model capable of providing propagation parameters for a communications channel between mobile vehicles and insight into the dominant physical propagation effects for individual paths. Verify the model against Army experimental data measured over or obtained for realistic terrain.

PHASE III DUAL USE APPLICATIONS: This topic will have major applications in improving the propagation models currently in use in industry and will enable realistic results for fully mobile distributed networks without fixed-base stations. These conditions arise, for example, when emergency police, fire or rescue services must operate outside the region of planned urban networks.

A97-028 TITLE: Low Temperature Decontaminant for Chemical and Biological Defense

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: To develop a decontaminant for use at subzero Centigrade temperatures.

DESCRIPTION: There is a clearly recognized requirement to be able to do decontamination at cold temperatures. The currently fielded decontaminates, Supertropical Bleach (STB) and DS2, are difficult or impossible to use at temperatures in the range -20□ to -30□ C. A further difficulty is that DS2 is forbidden for use on aircraft by the Air Force. Research is needed to develop a surfactant-based decontaminant system, such as a microemulsion or miceller solution, which contains an antifreeze-type solvent which can be diluted with water and used at these low temperatures. The system must be reactive, i.e. it should contain reagents which will rapidly destroy the solubilized contaminants, preferably catalytically and economically. Despite the reactivity, the corrosiveness to the material on which the decontaminant is applied should be minimal.

PHASE I: Formulate and optimize a surfactant-based decon system which can be used at -20□C. Incorporate reagents, preferably catalysts, which will destroy chemical warfare agents. Test the formulations with appropriate simulants to determine reaction kinetics and reaction products. Also test the formulation for compatibility with metals, rubbers, plastics, and painted surfaces.

PHASE II: Complete parametric optimization of the formulation and conduct testing with real chemical warfare agents to determine the true efficacy of the decon system. The system must be as good or better than STB or DS2 under similar

conditions. It will also be shown that the formulation is compatible with aviation deicing equipment, and ideally with the deicing solution itself. Determine shelf life and pot life of the formulation.

PHASE III DUAL USE APPLICATIONS: No capability to accomplish this mission at -20□ to -30□C. Considerable market in military and emergency civil decontamination applications.

U.S. Army Aviation Research, Development and Engineering Center (AVRDEC)

A97-029 TITLE: Laser-Based Universal Multipurpose Air Data System (LUMiAir)

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: The objective of this effort is to develop a multipurpose sensor system, using emerging laser-based sensor technology, that provides critical flight path management and mission data, is unaffected by aircraft configuration, and reduces the number and types of sensors required for safe effective Nap-of-the-Earth operations for Army rotorcraft and by both military and civilian rotorcraft operating in urban and hazardous remote areas. Critical flight path management data include; airspeed, altitude, ground speed, and height above the ground. Other functional capabilities include; improved air data measurements used for weapons fire control, obstacle/terrain detection, and intraformation communication.

DESCRIPTION: Current airspeed sensors on rotorcraft rely on total and static air pressure measurements (pitot-static tubes). These fixed pitot-static tube systems are unreliable below 30 knots, a speed where rotorcraft routinely operate in close proximity to the ground, obstacles, and terrain. Airspeed, wind, and/or other limitations are critical for rotorcraft during these near-earth operations. Low speed, omnidirectional air data sensors employed on attack and reconnaissance helicopters are affected by aircraft gross weight, center-of-gravity, rate-of-climb/descent, external stores configuration, etc. None of the existing air data systems provide sufficiently accurate air data throughout the helicopter airspeed range of rearward or sideward flight up to 50 knots and forward flight speeds up to 250 knots, especially when these other effects are considered. Emerging optical-based systems avoid these near-field effects by sampling air outside the rotors' influence. Significant development time is expended tuning current pitot-static systems on a new helicopter or one where aerodynamics have been modified. An optically-based air data system that is independent of the vehicle aerodynamic configuration can reduce the operating and support requirements by reducing the number and type of sensors and spares required and reduce integration time.

Precise measurement of local flow fields around weapons store positions, and down range at target locations, could be exploited by fire control of modern attack helicopters for ballistic fire control calculations. Perturbations, or noise, caused by the erratic readings of current air data sensors, translate into a ballistic dispersion of both gun and rocket weapons. An air data system with these capabilities can improve lethality of ballistic weapons on current and future Army rotorcraft.

Other optical systems that scan the area surrounding the rotorcraft have shown they can provide range and bearing data for obstacle/terrain detection, improved ground speed, and height above the ground. Early attempts to provide the obstacle detection functionality identified large data processing power and high scan efficiency requirements. A smart system that actively manages sensor scan, sampling, and processing with current system reliability would reduce these requirements substantially. This would make feasible 360- degree sensor coverage of the rotorcraft which will enhance safety and mission effectiveness. Redundant sensors with the multifunctional capabilities described could be separated, further increasing safety and reducing operating and support costs for both civilian and military rotorcraft.

PHASE I: Analyze current and near-term advanced rotorcraft pilotage subsystems capabilities and optical technology to select candidate functions for integration into LUMiAir. Develop a conceptual design to assess the feasibility of a universal multipurpose laser-based system for rotorcraft. The design will be applicable to all force-modernization aircraft and have an airspeed and windspeed accuracy of 1 km/hr and direction accuracy of 1 degree for the entire helicopter flight airspeed envelope. The system design will be capable of sensing windspeed and direction at target ranges up to 6 km but should emphasize multiple use of sensor signal for obstacle detection, height above the ground, and other growth capabilities, such as, air quality/contents sampling, temperature and pressure sensing, target acquisition, etc. Low-observable attributes and power, weight, and volume characteristics will be described, as well as signal and data processing requirements. Define a universal multipurpose laser-based system for rotorcraft for Phase II development.

PHASE II: The LUMiAir design will be further developed. Prototype hardware will be fabricated and tested to demonstrate affordably a practical multifunctional system can achieve rotorcraft pilotage requirements. Based on the maturity of the Phase II system, a government provided helicopter would be available for an in flight assessment. Analysis of LUMiAir and truth data will be performed. Methods to analyze and simulate the performance of LUMiAir for various flight and fire control and display applications will also be developed.

PHASE III DUAL USE APPLICATIONS: Urban uses for the helicopter are commonplace and expanding. Police, emergency Medical Services, Forestry Services, Traffic Control, etc. operate near terrain, obstacles, hazards, and in remote areas, similar to Army Nap-of-the- Earth requirements. A universal multipurpose sensor system that provides critical flight path management and mission data in these environments will enhance safe flight and the availability to provide life-critical aid, information, and services. Combining functions into a single sensor package will reduce operating and support costs and provide an affordable solution for safe civil rotorcraft operations. Growth potential exists for the detection of microburst induced windshear.

A97-030 TITLE: High Strength, Lightweight Cable/Tape for Cargo-Handling Winches

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: To develop a tape tension member, fabricated with advanced materials, and configured with conductors to provide signals to the suspended hook for use in advanced external winch systems. The tension member shall have the following features: (1) 18,000 lb. lift capability with a 5:1 safety factor, and (2) 100 ft of usable length.

DESCRIPTION: Development of high-strength fibers such as kevlar have resulted in tension members with smaller cross-sectional areas than steel tension members of equivalent strength. For example, a conventional steel cable of 0.75 in. diameter, weighing 105 lbs, with a length of 105 ft., could potentially be replaced by a kevlar tape 3 in. wide by 0.219 in. thick and weigh less than 20 lb. for 105 ft. These developments in turn suggest that a flat tape tension member could be wound over a spool to produce a hoist of compact size and low weight. A research and developmental program is required to develop a tape tension member for use in an advanced external winch system as described in the Advanced Cargo Handling Systems (ACHS) Demonstration program (USAAVSCOM TR 90-D-1). Further research and development needs to be done on the tension member to establish:

a. The buildup of forces in the reel drum as tensioned tape is overwrapped on the reel and the effect of tape width on reel flange design;
b. The cutter charge required and the guillotine blade shape or other candidate concepts for the tape-tension emergency cutting system;
c. Friction coefficient and tension requirements;
d. A length-of-tape-deployed sensor;
e. The behavior of tape-tension members when suspended below a
helicopter, throughout the helicopter speed and lift-load range and with a spectrum of weights attached; and
f. The required stored-energy characteristics of the tape tension member.

PHASE I: Identify, discuss, and evaluate existing or new technology to include development risk and methodology, necessary for identifying design, development, and testing requirements for both technology and hardware.

PHASE II: Fabricate a prototype tape system for demonstration and subject to qualification testing. Demonstrate the capabilities of the technology and hardware development, laboratory demonstration and Army Field use demonstration/evaluation.

PHASE III DUAL USE APPLICATIONS: Development and implementation of a new, smaller, lightweight winching system would have application to both military and commercial sectors.

A97-031 TITLE: Lightweight Ballistic Protection Systems for Helicopters

KEY TECHNOLOGY AREA: Clothing, Textiles and Food

OBJECTIVE: To develop innovative lightweight ballistic protection.

DESCRIPTION: Future mission scenarios for Army helicopters call for close support of combat operations, resulting in exposure to extremely high concentrations of enemy ground fire. This intense fire will pose a formidable threat to Army attack and utility helicopters and other lightweight systems, where current levels of ballistic protection are known to severely limit their operational deployment. This combat vulnerability is due in part to the parasitic weight of current ballistic protection (armor) systems. Previous programs have reduced the weight of armor using state-of-the-art ceramic and backing materials laminated together. A need exists for research to be conducted in the area of lightweight helicopter armor and which addresses innovative approaches to armor design. Some examples of innovative design approaches may be: spaced armor design, fluid layers, electromagnetic fields, or use of new exotic materials.

PHASE I: The proposer should search existing lightweight armor technology to identify candidates for improved helicopter ballistic protection. If none currently exists, the proposer would develop a methodology/ technique for creating such a system. Upon completing the task, a report discussing the design concept which demonstrates potential for substantial weight

reduction through the use of new and innovative design approaches would be presented with the proposer's recommendations. Emphasis should be on reducing size, weight, and cost of a complete ballistic protection system. A breadboard model of the innovative ballistic protection design concept shall be fabricated for use in demonstrating the concept.

PHASE II: The proposer would take the information obtained in Phase I and fabricate a mockup ballistic system to be tested with various threats.

PHASE III DUAL USE APPLICATIONS: This technology can be applied to commercial vehicles including helicopters, airplanes, and VIP limousines for protection against handgun and rifle threats. The technology would offer greater protection for less weight.

A97-032 TITLE: Occupant Head Proximity Sensor/Logic for Helicopter Cockpit Air Bag System (CABS)

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: This objective is two-fold: 1) to conceptualize a proximity sensor system for determining occupant head position within a helicopter cockpit with respect to placing distinct protective air bag modules, and 2) to devise microprocessor-based logic required to make air-bag fire/no-fire decisions during a crash impact situation so as to minimize occupant injury potential.

DESCRIPTION: The Cockpit Air Bag System (CABS) currently being developed for a variety of military platforms is designed to supplement existing belt restraints to greatly decrease the incidence and severity of head and upper torso injuries during potentially survivable crashes. The system is presently designed to function all air bags simultaneously when triggered by a single, reliable, triaxial crash sensor. Under certain pre-impact conditions; however, occupants would be better served by having certain air bags of the system disabled so as not to inflate during the primary crash impact. This is particularly true for aviators who may be prepositioned very near an air bag module. Examples are when a crewman is in a head-down position using a weapons sight (on which is located the forward bag module), or a crewman with head/torso leaned far to his right or left, very near a lateral bag module. To achieve quick bag positioning, bag deployment velocities may approach 200 MPH. Cockpit occupants can thus conceivably suffer significant injuries if their heads are in the deployment path. A sensor capability is sought to continuously monitor the proximity of the pilot's and copilot's heads to the various air bag modules located within the cockpit. This proximity sensor should also possess the instantaneous logic to make a "fire/no- fire" decision during a crash event, based on the injury potential presented to the affected crewman. This capability should selectively prevent the activation of any air bag of the system, based on occupant proximity, relative velocity between the occupant's head and the bag module, and any other pertinent parameters. Only through such a "smart" system will the full potential of cockpit air bags be realized.

PHASE I: The first phase will identify available candidate position sensor technologies, placing emphasis on ease of installation and integration with the current CABS design. Conceptual candidate designs will be evaluated for their merit. The operation logic or logic options will be developed which offer the best chance for out-of-position aviators to have protection from deploying air bag(s) during a typical crash sequence. This logic will be demonstrated through cockpit computer simulations of typical helicopter survivable crash impacts.

PHASE II: Generate detail designs and fabricate two different prototype head sensor systems that use different means of determining head proximity to cockpit air bag modules. Perform simulated crash testing to evaluate each system and present the results.

PHASE III DUAL USE APPLICATIONS: There is a pressing need in commercial air bag systems for automobiles to improve the safety of passenger-side bags, especially for non-adult (low mass) occupants. A unique occupant proximity sensing system should have direct applicability to the commercial automotive market by addressing this pressing safety need.

A97-033 TITLE: Integral Airfoil Actuation Concepts for On-Blade Active Control

KEY TECHNOLOGY AREA: Air Vehicle/Space Vehicles

OBJECTIVE: Develop on-blade active control design concepts that integrate the actuation and rotor blade structural functions to provide a continuous rather than a discrete component system.

DESCRIPTION: Recent research in smart materials and structures has resulted in significant technical progress that promises to revolutionize future military and civil rotorcraft performance and effectiveness. The concept of interest here is to combine smart materials with on-blade aerodynamic control (with trailing edge flaps or elevons) to actively control the dynamic response of the rotor blade, thereby eliminating most of the inherent blade loads and fuselage vibration. Current piezo-ceramic and magnetostrictive smart materials are being employed to provide the actuation function for such concepts, although more conventional electric actuation concepts have also shown promise. One important area of related technology that has received very little attention, but needs to be addressed, is the elastic and structural design of the blade for practical application of on-blade active control. Typical concepts employing hinged trailing edge control surfaces, while effective in generating the necessary aerodynamic lift and pitching moments for control purposes, are impractical for fielded systems. The complexity associated with mechanical linkages and components such as hinges, bell cranks, and pushrods will adversely affect reliability and maintainability, and negate the original benefits of on-blade active controls. The objective of this effort is to develop design approaches and concepts to integrate the actuation system with the blade structure to achieve a continuous deformation of the airfoil contour near the trailing edge of the blade. Such approaches will require large surface strains to accommodate the realistic airfoil trailing edge camber changes needed to generate useful aerodynamic lift and moment. New design approaches will be required, and probably new and unconventional materials may need to be examined for such novel applications. Such research should address innovative approaches to blade structural design as well as application of advanced analytical techniques to predict elastic properties and blade deformation characteristics. Structural dynamics, fatigue, and aeroelastic characteristics of the blade should be considered as well.

PHASE I: Develop design concepts and supporting analysis techniques as appropriate. Evaluate static structural response as well as aeroelastic response of concepts applied to typical rotor blades.

PHASE II: Fabricate representative prototype blade specimens and conduct laboratory tests to demonstrate functionality and evaluate actuation force and trailing edge displacement performance.

PHASE III DUAL USE APPLICATIONS: Applicable to military and civil rotorcraft. This topic addresses one of the key technical barriers to one of the most promising advancements in rotorcraft technology. If successful, such technology will find application to most future rotorcraft and likely contribute to considerable expansion of the rotorcraft market by virtue or reduced operating costs, improved performance, and increased crew and passenger comfort. Commercial potential is considered to be very significant.

A97-034 TITLE: Advanced Video Processing Algorithm Development

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: The objective of this program is the development of algorithms to enhance the capabilities of helicopter and fixed-wing video capture, transmission, reception, and display systems.

DESCRIPTION: Current airborne video systems generally include hardware which supports a full rate frame-grabbing capability for standard video encoding formats such as National Television Standards Committee (NTSC) and Phase Alteration Line (PAL). Video data is compressed and transmitted to receiving nodes at the frame rates supported by the data link. Occasionally, individual frames are annotated by the pilot or crew members with a limited library of symbols before transmission. Some platforms provide additional information such as current position, heading, speed, and the video camera lens focal length. In addition, audio input and output capability is normally available, and an eyeball tracking system may also be available. Suggested system enhancements focus on the development of better frame and live video error-tolerant compression algorithms suitable for legacy tactical data-links as well as future Army efforts and advances in video technology, input for audio image annotation, and exploitation of position and range information to determine the position of objects.

PHASE I: The contractor shall investigate the current technology and propose how the current or newly devised algorithms can be exploited to enhance the capabilities of aircraft video systems. This phase focuses on the process and application level development. As such this topic focuses on the higher four layers of the OSI model. The goal of this phase is to provide the detailed architecture, process specification, and design needed prior to coding any algorithm as well as the algorithm itself. This algorithm should be easily portable to systems regardless of computer processing hardware (X-86 versus 68000 or R4400 or R10000). The algorithm should be capable of imbedding into weapons systems and will be required in ADA.

PHASE II: The contractor shall develop detailed implementation requirements for an appropriate hardware system, develop the required software, and demonstrate the capabilities of one or more of the approaches from Phase I using hardware such as the Improved Data Modem and video from a target tracking device that can be or is integrated into airborne platforms.

PHASE III DUAL USE APPLICATIONS: Police and emergency agency video data links; digital map situational awareness display systems that support video and icon overlays.

A97-035 TITLE: Low Cost Rotorcraft Avionics

KEY TECHNOLOGY AREA: Air Vehicle/Space Vehicles

OBJECTIVE: Develop and demonstrate technology to reduce the cost, weight, volume, or power requirements of Army rotorcraft avionics for upgrades of current systems or new developments for future applications.

DESCRIPTION: As rotorcraft avionics have increased in capability, they have also become an increasing share of the cost of upgrades and new systems. The Army, and Navy and Air Force, are expending considerable effort to reduce the cost of avionics, as well as to reduce weight, volume, power consumption, and other cost-related factors. This topic addresses the goals/objectives of the Sensors Defense Technology Area Plan (DTAP), Implementation Platform Electronics (Avionics) IPE(A) Technology Development Approach, and of the Integrated Platform Avionics Demonstration Defense Technical Objective (DTO). It will also address Operations and Support Cost Reduction (OSCR) for current and future Army helicopter systems. One high potential area for development of innovative technology is an open-system architecture suitable for real-time embedded systems. Such a system would allow the use of Commercial Off-the-Shelf (COTS) components, from multiple suppliers, on a variety of platform applications. Technology to allow reuse of software for real-time embedded processing would enable portions, or all, of these software products to be used for the same functions in other helicopter systems. As efforts have been in progress to miniaturize electronics, there is also a need for high efficiency, low-voltage, on-module DC-DC converters.

PHASE I: Identify and develop innovative technologies to reduce cost, weight, volume, or power requirements of real-time embedded avionics on Army helicopter systems, and develop a demonstration plan to verify the performance and potential savings of these technology insertions.

PHASE II: Conduct demonstrations of the most cost-effective avionics technologies, demonstrating use of components from multiple vendors, and applicability to a variety of platforms, as well as future applications.

PHASE III DUAL USE APPLICATIONS: Technology, as described, will have a significant dual-use potential, both within the DoD and the commercial rotorcraft markets.

A97-036 TITLE: Innovative Active Blade Design Concepts to Reduce Rotor Blade-Vortex Interaction Noise Reduction

KEY TECHNOLOGY AREA: Air Vehicle/Space Vehicles

OBJECTIVE: To develop innovative active blade design concepts using smart materials/structures to reduce rotor blade-vortex interaction noise. Develop accurate and efficient Computational Fluid Dynamics (CFD) algorithms and codes to calculate the blade aerostatic deformation and unsteady loads associated with these innovative concepts.

DESCRIPTION: Future military rotorcraft will require significant improvements in low detectability and high performance for air-to-air combat and Nap of Earth (NOE) operations. In recent years, substantial progress has been made in understanding and controlling rotor noise. Several parameters pertaining to control of rotor noise have been identified, such as tip vortex structures, blade aeroelastic deformation, and blade tip shapes. The objective of this research is to develop innovative blade design concepts using smart material/structures to substantially reduce rotor blade-vortex interaction noise and vibration, while improving the rotor performance. Significant progress has also been made in recent CFD research in predicting rotor blade-vortex interaction phenomena. Requirements for advanced CFD algorithms and codes include a minimal artificial dissipation to preserve the vortex structures. It is necessary that the proposer can demonstrate capability in these modeling areas, preferably with some previous applications to rotors.

PHASE I: Identify and evaluate advanced and innovative active blade design concepts using smart materials/structures to reduce rotor blade-vortex interaction noise and vibration, but without performance and weight penalties. Then, select a few practical rotor concepts and develop a tradeoff study of these concepts in terms of attributes such as rotor performance, weight, complexity, benefit, and cost. Demonstrate feasibility of approach by (a) calculating the airload during blade-vortex interactions in low-speed descent flight and validate with existing experimental data, and (b) performing accurate parametric analysis studies.

PHASE II: Preliminary evaluation of those concepts warranting further investigation shall be performed to verify the improvement potential. The fabrication and experimental testing of the final concept by means of a 10-ft. diameter scale model will be required to validate the resulting methodology. Wind tunnel and test stand facilities can be provided by the Government if required. Develop CFD codes to predict blade airload distribution and blade aeroelastic deformation during descent flight. Validate these codes with test data.

PHASE III DUAL USE APPLICATIONS: Technology as described will have a significant dual use potential both within DoD and the commercial rotorcraft market.

A97-037 TITLE: Simulation Evaluation of Innovative Helmet-Mounted Displays (HMDs)

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: To demonstrate a new and innovative display technology for presenting visual imagery to helicopter pilots. Investigate new technologies for the presentation of information by way of helmet- mounted displays (HMDs). Display hardware capable of supporting innovative presentation will be integrated into an Government helicopter simulation facility, and alternative presentation concepts will be evaluated.

DESCRIPTION: State-of-the-art HMDs suffer limitations in field-of- view, display format, and image quality. These limitations affect not only the ability of the device to present imagery and symbology to the pilot, but also the ability to integrate this information with that coming from the cockpit displays and the out-the-window view. Alternative display formats and aspect ratios are likely to allow creation of new displays that better support aircrews. For example, in a flight control task, an HMD that is considerably larger in azimuth than in elevation would allow presentation of symbology that stimulates the ambient visual system. Two issues must be addressed in order to evaluate the benefit of alternative HMD format technology: (1) Display hardware capable of supporting alternative display formats must be developed and integrated into a simulation test bed, and (2) Innovative display formats must be developed for testing in specific flight situations. The display should have a high pixel count, high brightness, and high contrast. It should be capable of being reconfigured to present displays that are optimized for specified flight or mission tasks. Evaluation of the HMD will involve development of symbol sets, optimized for specific tasks, that exploit the unique capabilities of the display.

PHASE I: Three tasks will be performed during the Phase I effort: 1) Identify candidate tasks from U.S. Army rotorcraft combat scenarios in which presenting information in an alternative format has the potential to improve system performance; 2) Develop a non-traditional display format (including placement and dynamics of symbology) to demonstrate the effectiveness of the concept. This concept will be demonstrated in a laboratory environment; and 3) Perform a technology review to identify display technologies that can be used to implement the innovative display and develop a plan for integrating that hardware into a government simulation facility.

PHASE II: The contractor will provide an innovative HMD system and integrate it into an government simulation facility for testing/evaluation. The contractor will implement innovative display formats/presentations, and evaluate these in simulation trials.

PHASE III DUAL USE APPLICATIONS: Innovative optimized HMDs offer potential applications for both military operations and commercial operations, such as medevac and transportation of external loads. There are also many potential applications beyond rotorcraft. Potential military applications include body-worn computers for maintenance and telemedicine, portable information systems, and vehicle/cockpit helmet-mounted displays. Commercial applications include design, training, and maintenance aids in industrial environments and visual augmentation tools for medical procedures.

U.S. Army Communications and Electronics Command (CECOM)

A97-038 TITLE: Compressed Voice Data over Variable Bit Rate ATM Adaptation Layer (AAL) Algorithm for Transporting

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: The program objective is the design, develop and test of an efficient algorithm for voice data over variable bit rate (VBR), ATM Adaptation Layer (AAL). The program will develop the algorithm in light of new efficient, compressed voice (e.g., 2.4 kbits per second) encoding techniques being development. The program will also investigate voice routing techniques (e.g., in-band and common control signaling) of compressed, VBR voice over ATM-based networks.

The program will allow limited access to the CECOM's Digital Integrated Lab/Testbed (DIL) will be allowed (although not required) as appropriate to fulfill the objectives. The DIL consists of interconnected distributed laboratories, testbeds, Battle Labs, field sites contractor testbeds, and simulations, along with technical engineering expertise at these facilities. The connected systems, combined with modeling and simulation, allow end-to-end testing of an individual system's capability to operate in the tactical environment. DESCRIPTION: A current solution for transporting non-compressed voice over ATM is to map the 8 bit PCM code words directly into ATM cell payloads using constant bit rate (CBR) ATM techniques. This solution is appropriate in the short term because of the existing voice infrastructure is based on 64 kbits per second, time division multiplexing (TDM)
However, voice is inherently VBR traffic. Despite the many significant advantages of digitizing voice, one major drawback is that the nominal 4 kHz analog voice signal can take up to 16 times as much bandwidth (e.g., assuming 1 Hz/bit). Digitized voice over ATM adds approximately 10% of ATM header overhead resulting in less bandwidth efficiency. There has been a significant effort in the past to develop voice circuit compression techniques for long-haul or bandwidth-limited voice networks. These include low rate, commercial encoding techniques (8 to 32 kbit per second voice) over ISDN networks.

DOD Digital Voice Processor Consortium (DDVPC) is currently overseeing the development of a new 2.4 kbits per second voice coder by the end of FY97. DDVPC supports the tri-service design and development of the new fixed point, coder algorithm on various hardware platforms. In addition, DOD is developing handheld, cellular / PCS / mobile satellite 2.4 kbits per second floating point algorithm-based terminal.

The key pay-off could be a 2.4 kbits per second voice coder that can support six voice circuits plus approximately 11% overhead in the MSE's or SINCGARS's 16 kbits per second channel. Alternately, the addition of 2.4 kbits per second voice coder could support one 2.4 kbits per second voice channel, 12 kbits per second data circuit, and approximately 1.334 kbits per second overhead for GPS data, error correction, etc. Currently, MSE and SINCGARS dedicate approximately 80% of their 16 kbits per second channels to voice circuits.

Compression gains for the tactical voice traffic, clearly, will be realized in the near future. The deployment of voice encoding equipment in current tactical networks may push network resources to the limit as voice bandwidth requirements are reduced and data requirements are maximized. However, the addition of voice compression techniques to integrated voice, data, video networks like ISDN/B-ISDN (ATM) may not be as simple as it will be for conventional networks. The Army must, therefore, investigate and develop alternative ATM-based, network architectures extending voice bandwidth efficient techniques to the tactical, integrated B-ISDN (ATM), ISDN, and tactical packet/circuit switched interfaces.

NOTE: The commercial and government internetworking communities are at the forefront developing high speed data communications and networking. A primary output of the effort is the development of Open Systems Interconnection (OSI) architecture. The OSI architecture represents internetworking functionality as seven distinct layers defined by intra layer network standards and inter layer network protocols. The upper layers - application, presentation, and session - provide users a transport service. The lower layers - network, data link and physical - provide users a network service necessary to interact with a given physical network. This topic investigates the processes related to network service support, OSI layers 1 through 3, offered by non conventional, high speed networks, such as ISDN/B-ISDN (ATM). The topic is investigating the support provided by high speed network service, not unlike OSI 1-3, of integrated, voice, data, video associated with the OSI transport service.

PHASE I: A 6 month feasibility study and tradeoff analysis for compressed voice data over VBR ATM Adaptation Layer (AAL) techniques. Determine which compressed voice data over VBR AAL technique would be most efficient and cost effective for implementation over tactical ISDN/B-ISDN (ATM).

PHASE II: An 18 month design, develop and test compressed voice data over VBR ATM algorithm effort. In addition, demonstrate and evaluate the new algorithm in a network call setup (in-band and common control signaling) configuration.

PHASE III DUAL USE APPLICATIONS: The DoD will support this research. DoD's Technical Architecture Framework for Information Management (TAFIM) requires improved system interoperability via a seamless, warfighter to CONUS connectivity. As a result, enhancements to tactical Internet/ATM networks will benefit from compressed voice over VBR ATM supporting the TAFIM objectives. DoD Digital Voice Processor Consortium (DDVPC) provides the focal point for the coordination and development of advanced secure voice processing techniques such as:

1. The 2400 bps Linear Predictive Coder (LPC-10), used in the STU-II, STU-III, ANDVT, Minterm, Airterm, SCAMP, SCOTT, EMUT, and five NATO country terminals.
2. The 9600 bps Adaptive Predictive Coder used in the STU-II.
3. The 4800 bps Code Excited Linear Predictive Coder used in the STU-III. DDVPC coordinates secure voice research, development, and planning between the various DoD activities.
4. The just introduced, Secured Terminal Equipment (STE) provides enhanced capabilities that support new applications (e.g., video) while maintaining backward compatibility to the STU-III. The STE products are compatible with National ISDN 1 (NI-1) and National ISDN 2 (NI-2) and with the analog Public Switched Telephone Network (PSTN). The ISDN compatible STE provides the data throughput and digital connections permitting "toll quality," secure voice (32 kbits per second), fast data rates (up to 128 kbits per second), secure three party conferencing and STU-III compatible modes. The STE's emulate STU-IIIs when connected to the analog PSTN.

The proposed algorithm will also have wide commercial use. The commercial community requires an efficient, variable bit rate (VBR) ATM Adaptation Layer (AAL) algorithm for voice data for a commercial ISDN/B-ISDN network environment. Commercial markets will readily support this research and development.

A97-039 TITLE: Antennas for Satellite Communications-on-the-Move

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To develop vehicular satellite communication antenna systems for all military (UHF, SHF, EHF) and commercial (C, Ku) frequency bands for tactical / strategic satellite communications on- the-move. Innovative solutions, including, but not limited to, the use of photonics, should provide practical and cost-effective technology solutions to the technical barriers associated with these antenna systems.

DESCRIPTION: Commercial satellite antenna systems have been developed that provide vehicular stop-and-point capability, and maritime / aircraft on-the-move satellite communications capability. These antenna systems utilize small, wide-beamwidth receiver antennas to provide initial pointing and subsequent tracking of high power satellites in the relatively benign environment of aeronautical and nautical yaw, roll, and pitch rates and angles. The desired characteristics of the satellite on-the-move antenna systems include, but should not be limited to, maximum gain with minimal size, mountable on various military vehicles, ability to track a satellite while the vehicle is in motion, ruggedized (e.g., able to withstand moderate impacts and harsh environmental conditions), low profile, and operate in one or more of the military frequency bands (C, X, and Ku) and, optionally, in commercial bands. Providing a methodology to initially position the antenna automatically to point to the satellite and subsequently maintain the pointing angle (tracking) during vehicle motions is critical. The methodology and mechanism for accomplishing pointing and tracking may differ in the various frequency bands specified.

PHASE I: Provide a research report on the current state-of-the- art in satellite on-the-move antenna systems. Provide research and analysis, and an initial design report; include technical objectives, tradeoff analyses, system requirements, design approach, component feasibility/availability analysis, and functional specifications/diagrams/descriptions for the proposed antenna system.

PHASE II: Develop two prototype systems. The first prototype will be suitable for laboratory demonstration of the pointing and tracking technology under expected environmental (temperature, vibration, shock) conditions. The second prototype will be a complete system, including vehicle mounting hardware, and will be suitable for field demonstrations at highway speed on improved roads, and at slow speed on unimproved roads and off-road.

PHASE III DUAL USE APPLICATIONS: The use of commercial satellite communications on aircraft, ships, buses, automobiles, and recreational vehicles, for both business and personal entertainment, is expanding at a rapid rate. The desire of the commercial user for satellite reception / communication on-the-move provides a rapidly expanding market for this technology. Current commercial satellite communication on-the-move development efforts are intended primarily for reception of entertainment television programming on-the-move in the benign environment of the interstate highway. This program will develop the additional capability to transmit and receive voice, video, and data via satellite while on the move, and in less ideal harsh off-road / unimproved-road environments. The technology developed could be used by the commercial developer to improve on-the- move performance and expand into the off-road / unimproved-road consumer sector.

A97-040 TITLE: Low Power Helmet-Mounted Display Development

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop and demonstrate a low-power, low-cost, miniature display suitable for use in Army Head Mounted Display (HMD) systems (Aviation, Armor, and Infantry) and with significantly improved day/night imaging characteristics. Of particular interest is low- power technology that improves display gray-scale/contrast, matrix and motion related artifacts, and night/day dimming range.

DESCRIPTION: Today's soldier requires enhanced imaging capabilities to remain effective under all battlefield conditions. The collection and presentation of imagery and data to the soldier requires a display which is capable of simultaneously displaying high-resolution sensor video, tactical data, and graphics. These data must be useable by the soldier under all battlefield atmospheric and environmental conditions. For the soldier, low-power consumption is of paramount importance. A display which will permit untethered imaging capability during extended missions requires improved power and luminous efficiency. New approaches to miniature displays and display driver architectures suitable for use in light/weight HMD's are sought which will: (1) increase the number of discernible gray levels, (2) increase dynamic range (instantaneous and time-varying), (3) expand the dimming range (to accommodate overcast starlight to daylight lighting conditions), and (4) reduce the existence of both spatial- and time-based image artifacts. Device architecture should initially be capable of monochrome VGA & RS-170 with a well-defined growth path to higher resolutions (>1K2) and color capability. Proper emphasis shall be given to state-of-the-art HMD optics and sensors such that overall HMD system performance is not sacrificed for display performance or yield.

PHASE I: Develop a laboratory-level concept demonstration unit which provides the required performance outlined in the description. At the end of Phase I, a functional demonstration unit will be delivered to the government, along with a comprehensive report detailing the design and performance of the unit.

PHASE II: Design, fabricate, and test a prototype display unit suitable for integration into an HMD system. At the end of Phase II, a functional prototype display suitable for integration into a working HMD system will be delivered to the Government. A manufacturing plan for high-volume, low-cost production will also be provided to the Government at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: A low-cost, low-power, high- performance video display has potential for use in many untethered applications, such as law enforcement, fire-fighting, education, inventory control, entertainment, virtual screens for mobile computing, and interactive virtual environments.

A97-041 TITLE: New Multipath and Co-channel Interference Suppression Techniques for Digital Data

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To investigate, develop, and demonstrate improved multipath and co-channel interference (CCI) suppression methods for digital communications signals that are based on recently emerging Per- Survivor Processing (PSP) techniques.

DESCRIPTION: Modern communications systems are frequently limited in capacity by the ability to reuse frequencies in the radio spectrum and interference due to multipath fading. Frequency reuse is usually limited by co-channel interference caused by another communications user operating on the same, or nearly the same, frequency (in-band) in the same geographic area. Multipath interference occurs when the main signal path is simultaneously received along with reflected and delayed versions of the same transmitted signal. Traditional design methods for digital systems operating over a noisy and dispersive communications channel usually employ an adaptive equalizer for channel estimation and acquisition. A decision feedback equalizer has been used in some cases to mitigate interference effects. PSP affords a general framework for approximating an optimum Maximum Likelihood Sequence Estimation receiver in an uncertain environment, such as an unknown intersymbol interference (ISI) channel. Per-Survivor Processing provides a method of estimating unknown parameters within the structure of a Viterbi algorithm. The data sequence associated with each survivor in the Viterbi processor is used as data-aiding sequence for the "per-survivor" estimation of the unknown parameter. This research will attempt to use these PSP techniques in the development of multipath and co-channel interference mitigation methods.

PHASE I: Investigate theoretical approaches for multipath and co- channel interference mitigation using PSP; develop and simulate promising methods and techniques; evaluate and compare the performance of PSP-based techniques versus other methods; and document the approach, design, and performance results in a Phase I report.

PHASE II: Implement and demonstrate computationally-efficient techniques on appropriate commercially-available processing hardware (e.g., a 6U Versa Module Europa (6U VME) Digital Signal Processor (DSP) or vector/array processors) to illustrate the operational feasibility and functionality of the algorithms in a realistic signal environment. The result of Phase II will be a demonstration prototype that employs PSP-based techniques for multipath and co-channel interference mitigation of digital communications.

PHASE III DUAL USE APPLICATIONS: This technology would have tremendous application in the commercial communications market. Communications systems and networks employing digital signaling schemes would all benefit from these techniques. Mobile communications systems, such as digital cellular phones and fax/modems, and the emerging Personal Communication Systems/Networks are just a few of the potential commercial markets in the communications industry.

A97-042 TITLE: Monolithically Integrated HgCdTe Staring Infrared Focal Plane Array (IFRPA)

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a technology for producing a megapixel staring infrared focal plane array with the functions of optical detection and charge readout monolithically integrated on a common silicon wafer. Demonstrate this technology by fabricating and delivering a prototype of this array.

DESCRIPTION: DoD surveillance and target acquisition missions share a common need for long standoff distance and wide field of view. Staring Infrared Focal Plane Arrays with high pixel count and density based on the HgCdTe materials' system have the potential to satisfy these requirements. The baseline process for fabricating IRFPAs is a hybrid technology wherein HgCdTe detector array chips and Si readout chips are produced separately and joined element by element with Indium. The size and hence the number of pixels in hybrid arrays are limited by the thermal expansion mismatch between HgCdTe and Si. A cost effective and robust alternative would be an IC-like technology where detector and readout circuits are monolithically integrated on a common silicon wafer. Innovative concepts are sought for achieving this integration. IRFPA design objectives include LWIR spectral response, 1280 X 960 array size, 25im pitch, p on n detector technology, 60Hz frame rate, and 77K operating temperature.

PHASE I: Design a monolithic IRFPA according to the objectives listed above and with particular attention to maximizing the optical fill factor. List the processing steps that will be required to fabricate the IRFPA and assign a risk to each step relative to the current state of the art. Demonstrate feasibility of a vapor phase process for achieving device-quality epitaxy of HgCdTe detectors on Si wafers by fabricating and testing an MWIR or LWIR diode. This process must be amenable to scale-up to large-area arrays and must be entirely compatible with the maximum temperature allowed for a Si readout circuit.

PHASE II: Design and fabricate a Si ROIC. Demonstrate a detector/readout-circuit interconnect technology which is compatible with both HgCdTe and Si. Fabricate and test a monolithically integrated MWIR or LWIR HgCdTe IRFPA. Perform an imaging demonstration with this array.

PHASE III DUAL USE APPLICATIONS: All infrared systems used in surveillance, automotive collision avoidance, and in fire-fighting would benefit from the high resolution, extended field of view, and simplicity of design of a large-area staring IRFPA.

A97-043 TITLE: Photonic And Microwave Transmit/Receive (T/R) Modules For Optically-Controlled Phased Array Antennas

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: To develop low-cost photonic and microwave transmit/receive (T/R) modules and antenna elements for optically-controlled phased array antennas. The devices will operate at a nominal optical wavelength of 1319 nm. The module design (or family of designs) will accommodate RF carriers from 7 to 60 GHz and allow an antenna element spacing of approximately lambda/2. The near-term goal is a photonic/microwave hybrid structure. In this program, a detailed study of the module configuration and performance parameters will be undertaken.

DESCRIPTION: Communications and Electronics Command (CECOM) is developing technology leading to the demonstration of optically- controlled phased array communications sub-systems for Army communications on-the-move (OTM). Carrier frequencies might vary from 7 to 60 GHz, with data rates of 2.4 Kb/s to 155 Mb/s or more. Adaptive multiple antenna beams and adaptive null capabilities will ultimately be required. Major emphasis is being placed on a high degree of photonic integration to develop modular, scalable, and "frequency independent" subsystems for multiple applications and to reduce size, weight, and cost, thus leading to a practical realization for Army tactical systems. Near-term emphasis is on optical phase control. These systems will support the Army initiative to "digitize the battlefield." CECOM has already initiated research and development contracts in support of some aspects of these sub-systems. The resulting T/R modules will be incorporated into the optical heterodyne phased array test bed being developed at CECOM. Through ongoing and planned contractual efforts, this test bed is migrating toward an objective architecture for an optically-controlled phased array antenna subsystem for tactical communications on-the-move. An end result would be the incorporation in a prototype phased array antenna system, and a fielded demonstration of this prototype system.

PHASE I: Design and develop photonic/microwave T/R modules and antenna elements. Computer techniques will be employed for the design and simulation of the photonic microwave circuitry. Electromagnetic (EM) computer simulation will be used to design the module housing as well as for planar antenna design. Proof- of-concept and feasibility will be shown.

PHASE II: In Phase II, a continued analysis based on Phase I conclusions will be performed. Photonic/microwave T/R modules and antenna elements will be fabricated and incorporated in a planar phased array antenna system and thoroughly characterized. A final demonstration of the prototype will show proof-of- concept.

PHASE III DUAL USE APPLICATIONS: The techniques developed under this topic will have an impact in personal communications systems, intelligent highways, electronic toll collection, cable television (CATV) and satellite systems.

A97-044 TITLE: Battle Damage Prediction (BDP)

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: To develop a prediction process which will assist the Battle Damage Assessment operator in performing timely damage estimates for both physical and functional damage assessment. For physical damage assessment, the intent is to investigate existing force/ratio models for their utility in predicting battle damage estimates, particularly in the direct-fire zone. Although models currently exist, automatic BDP calculations do not. Therefore, this effort will generate the required calculation methods and tools and develop a process for their use with appropriate force/ratio models. This topic will also investigate the use of EW models for the prediction of functional damage assessment.

Limited access to the CECOM's Digital Integrated Lab/Testbed (DIL) will be allowed (although not required) as appropriate to fulfill the objectives. The DIL consists of interconnected distributed laboratories, testbeds, Battle Labs, field sites contractor testbeds, and simulations, along with technical engineering expertise at these facilities. These connected systems, combined with modeling and simulation, allow end-to-end testing of an individual system's capability to operate in the tactical environment.

DESCRIPTION: Battle Damage Assessment (BDA) is defined as the timely and accurate estimation of damage resulting from the application of military force, either lethal or non-lethal, against an objective or target. BDA estimates can be time-consuming and can include both physical and functional damage assessment. Physical BDP models currently exist, however, the automatic calculations for these models do not. This research effort is directed at developing an automated process to use existing force/ratio models to calculate physical battle damage estimates in the direct-fire zone. In addition, investigate existing EW models and develop a process for incorporating them in predicting functional damage estimates. The resulting BDP deliverable will consist of an operational prototype which can be integrated with current BDA work at CECOM's Intelligence and Electronic Warfare Directorate (IEWD). In addition, this concept was developed in conjunction with Program Manager (PM) Intelligence Fusion personnel with an interest in using the resulting technology within All Source Analysis System (ASAS) Block II.

PHASE I: Study current force/ratio and Electronic Warfare (EW) models. Investigate their use in predicting battle damage estimates. Develop the required automatic calculations. Design a process for using the identified models, performing the associated automatic calculations, and presenting the results.

PHASE II: Implement and demonstrate a prototype of the Phase I design. Integrate the Phase II prototype with IEWD-designated systems.

PHASE III DUAL USE APPLICATIONS: The underlying principles of this technology would be applicable to generating physical damage estimates for any type of natural or man-made destruction for which predictive models exist. Such applications include predicting damage to areas affected by hurricanes, tornadoes, or other weather-related disasters, as well as damage to buildings resulting from terrorist bombs and/or natural causes such as earthquakes. This technology would also be useful in predicting the impact of natural and man-made interference in various types of communications systems.

A97-045 TITLE: Real-Time Image Fusion Processor for Helicopters and Land Vehicles Navigation

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop algorithms for combining the most salient features of registered infrared and near-infrared navigation sensor imagery into a single image. Implement the selected algorithms, in real-time, using commercially-available general-purpose processors or digital signal processing devices. Image fusion techniques may be implemented using gray scale or chromatic techniques.

DESCRIPTION: Wide field-of-view, unity magnification thermal- and image-intensified night vision sensors are used for helicopter navigation and driving applications. Thermal sensors provide cues on the terrain and the surrounding environment by sensing emitted radiation, i.e. temperature differences, and are independent of ambient illumination. Image-Intensified sensors provide cues using reflected radiation, i.e. light, and thus are not affected by poor thermal contrast. Since the information contained in the respective wavebands is uncorrelated, the most salient features from each can be combined to provide the aviator or driver with an unprecedented amount of operationally significant information. The fused image can be displayed on a Helmet-Mounted Display (HMD) or on a panel-mounted display. The imagery can be gray scale or color, depending upon the fusion approach. Display type does impact image fidelity, and the type of display used must be accounted for in the fusion design. Since navigation sensors are not primarily used for targeting, the quantitative user evaluation of image fusion algorithm

performance is nontrivial. The Army has designed a specific set of experiments to quantify the benefits of image fusion algorithms, using a known set of images. Since the high-fidelity imagery used for navigation tasks typically has more than 5 times the bandwidth of conventional sensors, innovative techniques are required to perform image fusion in real- time.

PHASE I: The vendor shall identify advanced fusion algorithms, concepts for hardware implementation, and shall provide fused images for evaluation. The Army will provide images from a high- resolution, second-generation thermal sensor and a co-located HDTV image intensified sensor for image fusion. The vendor shall assist the Army with designing and conducting experiments to evaluate image quality and the operational potential for the given fusion technique.

PHASE II: The vendor shall design and fabricate a real-time image fusion processor. Provide the capability to implement the Phase I image fusion algorithms on thermal- and image-intensified sensors that use the RS-343A, 1023-line specification with minimal latency. The fusion processor shall maximize the use of COTS image processing devices. The vendor shall assist in the laboratory and flight evaluation of the image fusion processor.

PHASE III DUAL USE APPLICATIONS: Immediate application for such applications as surveillance, police, fire, search and rescue, machine vision and medical imaging and image processing.

A97-046 TITLE: Wireless and PCS Sub-Networks for Near Term Digital Radio/ Future Digital Radio

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Determine the effectiveness and usability of open architecture systems by evaluating enhancements for the Near Term Digital Radio (NTDR) by using emerging commercially based PCS/Wireless LAN technology areas that might be included in the Future Digital Radio (FDR).

Limited access to the CECOM's Digital Integrated Lab/Testbed (DIL) will be allowed (although not required) as appropriate to fulfill the objectives. The DIL consists of interconnected distributed laboratories, testbeds, Battle Labs, field sites contractor testbeds, and simulations, along with technical engineering expertise at these facilities. The connected systems, combined with modeling and simulation, allow end-to-end testing of an individual system's capability to operate in the tactical environment.

DESCRIPTION: Deliver lab models with a PCS/wireless LAN capability (voice and data) built into NTDR or the lab models that the Government currently has to prototype the DCD/BCBL(G) WIN architecture. Embed a wireless module (PC 104) in a radio and include 8 wireless LAN terminal devices to set up a wireless LAN network for a command post or for dismounted soldiers (WIN goal is 3 Mbps at 3 km.). Interface this wireless LAN into the NTDR network using the NTDR router so as to pass traffic between/through the two networks (NTDR/SDR and wireless LAN). Show an IP voice capability. COMSEC is desired but a growth path shall be reserved/identified. Determine if it is possible to reuse NTDR software in a different frequency range to set up another tier in the network.

PHASE I: Deliver 1-2 lab models with a PCS/wireless LAN capability (voice and data) integrated with but not necessarily built into NTDR or the lab models that the Government currently has to prototype the DCD/BCBL(G) WIN architecture. Externally integrate wireless module with the radio and include 8 wireless LAN terminal devices to set up a wireless LAN network for a command post or for dismounted soldiers (WIN goal is 3 Mbps at 3 km.). Interface this wireless LAN into the NTDR network using the NTDR router so as to pass traffic between/through the two networks (NTDR/SDR and wireless LAN). Referring to above, determine if it is possible to reuse NTDR software in a different frequency range to set up another tier in the network.

PHASE II: Deliver 1-2 lab models with a PCS/wireless LAN capability (voice and data) built into NTDR or the lab models that the Government currently has to prototype the DCD/BCBL(G) WIN architecture. Using a PC 104 board, embed a wireless module in a radio and include 8 wireless LAN terminal devices to set up a wireless LAN network for a command post or for dismounted soldiers (WIN goal is 3 Mbps at 3 km.). Interface this wireless LAN into the NTDR network using the NTDR router so as to pass traffic between/through the two networks (NTDR/SDR and wireless LAN). Show an IP voice capability between users in the same net and users located on a distant NTDR net that needs routing. COMSEC is desired but a growth path shall be reserved/identified.

PHASE III DUAL USE APPLICATIONS: Wireless LANs, Personal Communications, Networking, Voice/telephone over the Internet.

A97-047 TITLE: Transition to the Objective C4I Modeling and Simulation Development

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: To develop a plan to transition current Army command, control, communications, computers, and intelligence (C4I) modeling and simulation (M&S) products to an objective M&S environment that meets criteria established by the Army Enterprise Strategy Task 9 M&S Subgroup.

DESCRIPTION: Realizing the benefits of M&S in the RDA, ACR, and TEMO domains for C4I systems will require a significant improvement in M&S tools and practices. Current C4I M&S is done in isolation, with the C4I system as a stand-alone element and without regard to battlefield return-on-investment. Battlefield return-on-investment measures of effectiveness (MOEs) include the effect of the C4I technology on unit lethality, survivability, and operational tempo. These MOEs need to be examined at each echelon, from the individual soldier through echelons above corps level, to assess overall operational effectiveness of the system. C4I M&S must support virtual, constructive, and live simulations for all applications and domains.

The objective M&S environment for C4I systems must support the evaluation of C4I systems in the RDA, ACR, and TEMO domains in a timely manner in virtual, constructive, and live simulations, as appropriate. The environment must support the following activities: systems prototyping and performance analysis, advanced systems concepts evaluation, architecture (operational, functional, system) definition/evaluation (including what-if and traffic-loading analyses) doctrine development, training, and operational effectiveness evaluations. The environment must be readily reconfigurable and support requirements for real-time simulation. The objective simulation environment will support all phases of the C4I system life- cycle, from system concept definition through development, acquisition, and fielding, and post-deployment. The Army Enterprise Implementation Plan, Task 9 Action Plan, specifies the use of Department of Defense (DoD) compliant tools and methodologies, including the High-Level Architecture (HLA), to oversee the prioritization and integration of C4I models to facilitate trade-off analysis and validation of the Operational Architecture and the Technical Architecture and to support the efforts of the Architecture Control Committee. Toward this end, the Task 9 M&S Subgroup was formed to define a common environment to support evolving Army C4I M&S efforts. The objective M&S environment for C4I systems will support the evaluation of C4I systems in the research, development, and acquisition (RDA); advanced concepts requirements (ACR); and training, exercises, and military operations (TEMO) domains in a timely manner in virtual, constructive, and live simulations, as appropriate. The objective environment will provide flexibility, scalability, and cost- effectiveness, while promoting hardware and software reuse between organizations, and will provide interfaces to prototype/operational C4I systems.

Limited access to the CECOM's Digital Integrated Lab/Testbed (DIL) will be allowed (although not required) as appropriate to fulfill the objectives. The DIL consists of interconnected distributed laboratories, testbeds, Battle Labs, field sites contractor testbeds, and simulations, along with technical engineering expertise at these facilities. The connected systems, combined with modeling and simulation, allow end-to-end testing of an individual system's capability to operate in the tactical environment.

PHASE I: Develop a roadmap for transitioning existing M&S efforts so that the operational and systems architectures employed by organizations involved in C4I M&S can be met by the technical architecture developed by the Task 9 M&S Subgroup. The transition plan will include a detailed plan, at the resource and milestone level, for transitioning from existing M&S environments to the objective environment. The plan shall consider how the Government will transition to the objective environment as expeditiously as possible while ensuring that near-term digitization commitments are met. The plan will consider the following: requirements for new model development; adaptation of existing models, simulations, and databases; The transition plan will identify requirements for adapting existing models, simulations, and databases; interoperability requirements between new and existing models and simulations; physical plant, including hardware, software, and networking; configuration management; and validation, verification, and accreditation (VV&A).

PHASE II: As a pilot project, existing CECOM system performance models (SPMs) will be rehosted to the objective environment, using standards developed under the Task 9 M&S Subgroup study. A demonstration of a representative slice of the CAC2 SPM functionality will be conducted to demonstrate the feasibility of the concept. The results of this project will be documented in a technical report. The final report, including lessons learned, will be delivered at the conclusion of the demonstration.

PHASE III DUAL USE APPLICATIONS: Work described above will include commercially available tools. Potential interest to industry as a framework that allows the interoperability of models and simulations.

A97-048 TITLE: System Architecture Tool Design

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: System engineers designing advanced digitized system architectures for the Army utilize many tools for the analysis and evaluation of alternative architectural solutions. Among these are those that are used to document the alternatives in a such a manner to allow easy evaluation and modifications. These design alternatives are evaluated utilizing many of the modeling and simulation tools available within the Army. The modeling and simulation tools are automated but the translation between tools and system documentation are not.

The System Architecture (SA) designs for the evolving digitized Force XXI are presently being prepared manually. Therefore any change to the operational requirements or changes suggested by the modeling and simulation results which will affect the system architecture presently requires a manual update of the SA. Optimization of the system architecture requires rapid synthesis and analysis of the system architecture. An approach to alleviate this situation is to utilize an integrated tool suite to synthesize and optimize the SA. This proposal is to request funding for the documentation and analysis of tool requirements and development and preliminary design of a High Level Automated System Architecture Development Tool Suite.

Limited access to the CECOM's Digital Integrated Lab/Testbed (DIL) will be allowed (although not required) as appropriate to fulfill the objectives. The DIL consists of interconnected distributed laboratories, testbeds, Battle Labs, field sites contractor testbeds, and simulations, along with technical engineering expertise at these facilities. The connected systems, combined with modeling and simulation, allow end-to-end testing of an individual system's capability to operate in the tactical environment.

DESCRIPTION: The present System Architecture documentation is manually created from a variety of operational architecture database structures. The software applications used to create the myriad of products which describe the System Architecture are not integrated with each other or even compatible. The degree of automation is presently drawing tools. A change in the operational architecture of the force, requires a manual update of each of the products. This situation does not allow the system architect to rapidly evaluate alternative system architectural solutions and assess performance differences through modeling and simulation. In addition, configuration management of the system architecture so documented is a manual, time consuming and somewhat unwieldy job to manage. As an example more than twenty products are used to describe the TFXXI SA.

The products presently produced which document a System Architecture include the organizational Configuration Diagrams- the so called Horseblankets (and extended Horseblankets), Equipment Configuration Diagrams- which include OPFAC Equipment interconnection information, and information system configuration diagrams which provide the following views:

-Hardware view for example of the computer infrastructure
-Communication & Network view- which provides the communication link, router and communication hub information
-Application View- which provides information on location of specific application software
-Data View- provides information about location of databases and describes the database management system
-External Interfaces-describes interfaces to higher, parallel and joint forces systems
-Security view which provides information of the SA from a security system standpoint.

These views are presented now for TFXXI in the forms of Laydowns, Matrices and Diagrams - all difficult to analyze and optimize performance metrics through modeling and simulation.

PHASE I: The contractor will work with the government technical staff to develop a specification and concept of operation for an Automated Tool Suite which will take the various requirements of the Army Operational Architecture and automate the synthesis of the System Architecture.

PHASE II: The contractor will develop, design and demonstrate the automated tool suite by using it to synthesize and analyze Force XXI System Architectures. It will include design of the database structure and the algorithms necessary to transform the database information into models for simulation and optimization of performance. The algorithm will allow for both graphical and database representation of the SA, automatically transforming from one form to the other.

PHASE III DUAL USE APPLICATIONS: The tool will not be specifically designed only for use by the ARMY. The tool suite will allow commercial use in system synthesis and analysis, where a database description of system requirements must be turned into a system design optimized for performance. It is envisioned that such a tool suite has widespread commercial applications in the communications, transportation, building industries.

A97-049 TITLE: Micro-transmitter and Rangefinder

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop and demonstrate new and innovative designs of compact 1.5 ìm laser transmitters and eyesafe micro-laser rangefinders (ìLRF). The ìLRF shall consist of a 1.5 ìm laser transmitter that weighs less than 4 oz, emits approximately >50ìJ per pulse, has a pulse width of <20ns, and can operate at a >10 Hz repetition rate. The new rangefinder concepts must include power, processor, and interface components for a complete ranging-capable system. (Alternative laser waveforms, wavelengths, and processing techniques will also be considered to meet the ìLRF application).

DESCRIPTION: The U.S. Army initiated a program in the 1980's to develop new laser technologies that would result in a portable, eye- safe laser rangefinder. The result of the program was the 1.5 ìm Mini Eye-Safe Laser Infrared Observation Set (MELIOS). Now, a decade after the MELIOS development, the U.S. Army is searching for an even smaller eye-safe laser rangefinder for use by individual soldiers as required by the Army's Land Warrior Program. This new micro-laser rangefinder

(ìLRF) will be an integral component of the individual soldier's future weapon (the Objective Individual Compact Weapon (OICW)), fire control system. Range to the target is critical for the soldier to use OICW to accurately fire bursting munitions.

A 1.5 ìm micro laser transmitter with high peak-power is also necessary for applications such as target location and illumination. The ìLRF must be highly efficient and capable of robust operation throughout a temperature range of -30 to 50 degrees C. The transmitter can be a semiconductor laser, or bulk solid state laser with or without a wavelength shifter.

The ìLRF 's system specifications are a 3000±1 meter ranging capability (assuming a 7Km visibility day) to a man-sized target. Class I eye-safe operation (per ANSI Z136.1-1993) at a greater than 10 Hz firing rate, an integrated NIR laser diode for boresighting, and a total weight (including battery) of less than 8 ounces. Sighting optics have not been included since ìLRF will be boresighted (via integrated NIR laser diode) with an optical sensor mounted on the OICW for pointing.

PHASE I: Investigate new and innovative designs for ìLRF. Define requirements of the ìLRF based on mission definition and system design. Perform laser source, detector, processor, and readout/interface analysis. Modeling and analytical evaluation shall be used to predict the merits of the concepts. A baseline shall be established with detailed designs of the ìLRF for implementation. A breadboard prototype, ìLRF transmitter shall be constructed for concept proof-of-principle. The contractor shall demonstrate all laser and processor parameters defined in the objective on a small breadboard. A design path to reach the weight goals shall also be delivered at the end of Phase I.

PHASE II: Implementation of the ìLRF concepts and construction of ìLRF system. Prototype design of the ìLRF shall be evaluated. A ìLRF brassboard prototype, capable of light field operation shall be fabricated. The brassboard prototype designs shall be optimized for producibility and cost-effectiveness. Detailed design drawing and specification shall be developed. The contractor shall build 10 devices that meet all the design parameters.

PHASE III DUAL USE APPLICATIONS: This technology would have application for commercial range finder applications for recreational and industrial activities, perimeter security, and for target location or collision/obstacle avoidance sensors on automobiles and industrial robotics systems.

A97-050 TITLE: Tools for Rapid Development of Graphical Information System (GIS) Applications

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Demonstrate software technology that allows rapidly built and end-user modifiable geographic information applications.

As a component of the CECOM RDEC Digital Integrated Lab (DIL), the C2SID Software Prototyping Lab (SPL) will provide local and remote (via Internet) access to its network resources in support of SBIR development. In addition the SPL will help coordinate access to other DIL assets as appropriate.

DESCRIPTION: Rapid GIS application building technology has matured over the past several years to the point where the information and display contents of an application can be developed without programming. Similarly, large-scale application components, such as inter-application communication, legacy database access, expert systems, and geographic displays are now commercially available, thereby reducing the overall amount of code developed in traditionally programmed applications. The objective of this research is to investigate methods of incorporating these large-scale application components into non-programmed rapid GIS application development environments. Advancements in this technology would be highly beneficial for tactical military applications improving the commander's and soldier's view of the battlefield. A rapid development capability, supporting end-user tailorable displays, will allow on-demand development of operation- or command-specific software systems for displaying current battlefield condition. The modern battlefield is likely to be an urban area with feature data (e.g. hydrology, energy grids, gas lines, landmarks, etc.) beyond that found in a typical geographic database (e.g. simple topographic, political boundary, and coastline data). Commercial GIS systems provide this additional level of detail. A dynamic display capability, tailored to the needs of individual end-users, and interacting with existing software systems and/or databases, will therefore enhance the ability to plan and execute military operations in such urban areas.

PHASE I: Identify approaches for incorporating large-scale application components into non-programmed rapid GIS application building environments. Specify a dynamic geographic information display system that can be easily tailored to the needs and preferences of individual commands and operations. Evaluate the potential for constructing such a system from a component-based, rapid GIS application building environment.

PHASE II: Produce a prototype implementation of the component- based rapid GIS application development toolset. Develop experimental versions of command- or operation-specific dynamic geographic display systems.

PHASE III DUAL USE APPLICATIONS: Commercial opportunities for rapidly built GIS's are nearly limitless. Today, more and more businesses are making use of GIS's for sales targeting, navigation, public information, land use analysis, etc. This

research will provide a way to rapidly build such applications providing significant leverage in the commercial marketing and development of such systems.

A97-051 TITLE: Low Cost Ka Band Transmit/Receive (T/R) Module

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop and demonstrate a single or multichip, low power, Ka band T/R module (~ 35 GHz).

DESCRIPTION: Ground surveillance radars and on-the-move combat identification antennas need electronic scanning arrays to form and point beams. Except for specialized applications, the high cost of high-power RF module technology is prohibitive for many military as well as commercial applications. A cost and size reduction of the current technology multi-chip packaging is required. The Ka band module can be implemented using either phase-shifted and comparator source generator designs. Output power of at least 100 mw per radiating element is desired after a 16-18 dB gain. The receiver side needs 18-20 dB of gain with a PHEMT (pseudoheteromorphic high electronic mobility transistor) or other MOSFET low noise preamp. A 10% or better RF efficiency of the module is desired. Phase logic control should be at least five bits and be separated from the XMT (transmit) and RCV (receive) paths. The module logic will be serial- fed. The radiating element should be an integral part of the single or multi-chip module. A $100-$200 large quantity production, single or multi-chip module is desired.

PHASE I: Investigate and choose an appropriate technology. Choose a RF circuit architecture. Design and implement the digital control logic into a Programmable Logic Array Chip (PLA). Determine whether a low-cost single or multi-chip module can be mass-produced. The investigators should complete a computer simulated model and layout of the digital logic and RF components.

PHASE II: Translate the Phase I design into actual hardware for prototyping. The investigators can make design adjustments if necessary. Manufacturing a limited quantity of 50 to 100 operational packages for prototype testing on a candidate phased array system is required. The spacing between each of the radiating antenna elements will be approximately one-half a wavelength.

PHASE III DUAL USE APPLICATIONS: Potential markets for this technology are in collision avoidance systems, smart tags for law enforcement, and surveillance.

A97-052 TITLE: Investigation of Active Networking Components

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Investigate and demonstrate advanced networking technologies that allow users to define, develop, and, control the execution of programs and data at typically passive network devices.

As a component of the CECOM RDEC Digital Integrated Lab (DIL), the C2SID Software Prototyping Lab (SPL) will provide local and remote (via Internet) access to its network resources in support of SBIR development. In addition the SPL will help coordinate access to other DIL assets as appropriate.

DESCRIPTION: Current networking devices (e.g., routers, switches, and bridges) are for the most part passive devices in that, with the exception of header processing and fragmentation, they do not perform operations on the data they transmit. By developing active networking components, users could dynamically program the network itself to perform data manipulations such as filtering, compression, decompression, fusion, and custom distribution of the data being passed. Active network components would allow users to download small executables or executable scripts which could manipulate network data passing through the network. This would allow users to dynamically modify, customize, and update the network's data manipulation capabilities.

PHASE I: Identify approaches and methodologies suitable for development of an active network. Evaluate application areas which could most benefit from active network capabilities (e.g., Virtual Collaborative workspaces, Mobile Computing, Security Firewalls) and propose appropriate solutions. Evaluate the potential for constructing an active network.

PHASE II: Produce a prototype active network and demonstrate improvements in end-user applications due to the implemented active network technology. Evaluate feasibility of wide-spread active network implementation.

PHASE III DUAL USE APPLICATIONS: Commercial opportunities for active network components mirror those for military applications. Virtual collaboration with audio, video, and shared workspaces; mobile Computing; and Security Firewalls are examples of applications which exist in both the Military and commercial environments, and could benefit from active networking.

A97-053 TITLE: Enhanced Power Spectrum Analysis

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Demonstrate wide bandwidth, high dynamic range, near real- time power spectrum analysis of RF signals. Specific goals are >500 MHz analysis bandwidth and >45 dB dynamic range jointly with <10 microsecond analysis time. Frequency resolution better than 1/1000 of the analysis bandwidth is desired. The analysis band should be centered at 1 GHz for compatibility with related equipment currently under development. Candidate technologies should ultimately be compatible with implementation in the 6U Versa Module Europa (6U VME) card set format.

DESCRIPTION: Power spectrum analysis plays a critical role in advanced techniques for the detection and characterization of threat RF signals. The performance limitations of systems currently under development are determined directly by the characteristics of currently available power spectrum analyzers. These limitations include RF constraints (limited dynamic range, analysis bandwidth, and frequency resolution; extended time to intercept), operational constraints (excessive size, weight, and power consumption), and logistics related parameters (calibration and maintenance). Recent advances in a variety of electronic component technologies (charge coupled device (CCD) arrays, photodiodes, SAW devices, etc.) admit the possibility of improving many of these characteristics of power spectrum analyzers, and, by extension, improving Army capabilities for the detection and characterization of threat RF signals.

Improvements in these areas will directly contribute to Army goals to protect, sustain, and lighten the force.

PHASE I: Perform a technical/engineering analysis of the proposed power spectrum analysis technique and system architecture. Deliverables should include a rigorous description of the principle of operation of the candidate spectrum analysis technique and its hardware implementation. Deliverables should also include the identification of specific component technology and hardware goals, and a preliminary design for implementation during Phase II.

PHASE II: Based upon the Phase I results, develop and deliver a breadboard improved power spectrum analyzer. Deliverables should include a detailed analysis of the finalized design and a description of/rationale for decisions taken to optimize the design. The prototype will be tested prior to delivery and the achieved performance will be compared to that expected. Deliverables should also include a preliminary design for a 6UVME card set implementation.

PHASE III DUAL USE APPLICATIONS: The improved power spectrum analyzer will have direct commercial applications in communications network control and optimization. Specific commercial opportunities are anticipated in resource management of cellular telephone networks wherein near real-time power spectral analysis can provide critical information for the optimization of mobile subscriber connections/channel assignments. Current market potential is for the installation of one enhanced power spectrum analyzer per cell site as part of a distributed control system architecture.

A97-054 TITLE: Application of Imagery and Advanced Rendering Techniques to Battlespace Command and Control

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To enable real-time imagery and advanced graphics to be integrated with systems rendering 3D environments.

DESCRIPTION: Communications and Electronics Command (CECOM) requires assistance in the application of imagery, including video, and advanced graphics techniques to 2D and 3D renderings of a battlespace. Imagery may originate from aircraft, including UAVs, ground-based platforms, as well as space-based assets. Techniques are required which will allow image products to be texture-mapped onto 3D models, including terrain environments, in addition to 2D maps. Imagery needs to be ortho-registered and ortho-rectified, if possible. Emphasis should be placed on rapid turn-around from transmission to availability of data in a form useful to CECOM's Battle Planning and Visualization (BPV) prototype.

In the area of advanced rendering techniques, CECOM would like to enhance BPV with realistic renderings of the battlespace. Techniques are required to depict weather, sensor views, and cultural and natural features. Weather effects should include rain, snow, fog, dust, wind, seasonal changes, etc. Sensor views should include Forward Looking Infra-red (FLIR), Night Vision Goggles, radar, and others. Cultural and natural features should be addressed to the extent that accurate virtual environments can be created by "standing up" buildings, populating woodland regions, and more. All code must be developed in the industry standard graphics library, Open GL.

CECOM would also like to combine graphics and imagery wherever possible to enhance battlespace awareness and data comprehension. Examples might include texture mapping of imagery collected from the battlefield to 3D database models, hypertext-based video playbacks associated with simulated unit movements, and near real-time overlays of air-based imagery to terrain databases. The objective of this effort is to provide intuitive understanding and accurate depiction of the battlespace. All

software developed will be integrated into CECOM's BPV prototype and demonstrated on CECOM's Distributed Integrated Laboratory (DIL).

PHASE I: Efforts should be focused on the problems of geo- referencing, and geo-rectifying imagery so that it may be registered with existing elevation, vector, and raster data. The offeror should propose a technique for solving this problem and identify limitations. Phase I graphics efforts should be focused on an analysis of rendering techniques such as mip-mapping, bump- mapping, Level of Detail Models, etc., as to how they might be useful in battlespace data representation. Recommendations should be made to include techniques for two types of rendering: realistic and intuitive. Realistic representation might include fog, snow, rain, etc., while intuitive representation might include the best means for rendering a radar detection volume.

PHASE II: Focus on the development of tools which implement the techniques outlined in Phase I. The tools developed should minimize the time frame required to receive and process imagery such that it can be integrated into a 3D rendering system. A library of rendering routines will be defined and developed to meet the needs of CECOM's BPV prototype. Both types of renderings, realistic and intuitive, will be evaluated in Army Warfighting Experiments (AWEs), and modified as necessary. Effectiveness of software will be demonstrated in CECOM's DIL; data from Army Battle Command Systems (ABCS) including: red and blue forces, control measures, and weather, as well as real time imagery, will be received over the DIL and displayed in BPV.

PHASE III DUAL USE APPLICATIONS: This technology, which applies imagery and advanced graphics rendering techniques to synthetic environments will prove invaluable for situational awareness and planning in law enforcement and crisis management activities such as dealing with forest fires, floods, etc. Since the algorithms and techniques in this effort are implemented in Open GL, an industry standard graphics library, the source code developed will be portable to numerous hardware platforms. All types of graphics applications, ranging from engineering, to design, to entertainment will benefit from the results of this effort.

A97-055 TITLE: ISDN Model for Near-Term Digital Radio (NTDR)

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Determine the effectiveness and usability of open architecture systems by evaluating enhancements for the Near Term Digital Radio (NTDR) by using emerging commercially based ISDN technology areas that might be included in the Future Digital Radio (FDR).

Limited access to the CECOM's Digital Integrated Lab/Testbed (DIL) will be allowed (although not required) as appropriate to fulfill the objectives. The DIL consists of interconnected distributed laboratories, testbeds, Battle Labs, field sites contractor testbeds, and simulations, along with technical engineering expertise at these facilities. The connected systems, combined with modeling and simulation, allow end-to-end testing of an individual system's capability to operate in the tactical environment.

DESCRIPTION: Deliver lab models with an ISDN capability (voice and data) built into NTDR or the lab models that the Government currently has to prototype the Directorate of Combat/Battle Command Battle Lab (Gordon) (DCD/BCBL(G)) WIN architecture. Embed an ISDN module (PC 104) in a radio and include an ISDN plug for an ISDN device. Interface an ISDN device to communicate with another ISDN device through the radio.

PHASE I: Deliver 2 lab models with a PCS/wireless LAN capability (voice and data) integrated with but not necessarily built into NTDR or the lab models that the Government currently has to prototype the DCD/BCBL(G) WIN architecture. The lab models for this phase can have an external device for converting ISDN into a format that the radio can efficiently transmit.

PHASE II: Deliver 2 lab models with the ISDN mode built into NTDR or the lab models that the Government currently has to prototype the Directorate for Combat Developments/Battle Lab (Gordon) (DCD/BCBL(G)) WIN architecture. Using a PC 104 board, embed the ISDN module in a radio and include the interface port on the outside of the radio.

PHASE III DUAL USE APPLICATIONS: ISDN to Internet to ISDN capability, ISDN to IP to ISDN capability, Personal Communications, Networking.

A97-056 TITLE: Object-Based C2 Visualization Workstation Architecture

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Design and prototype a next-generation, object-based architecture for a visualization Command and Control Workstation

DESCRIPTION: Communications and Electronics Command (CECOM) is interested in developing an object-oriented Command and Control (C2) architecture which will support future C2 systems. This object-based architecture needs to address the current requirements of C2 systems such that re-configuration from one function to another is inherent in its design. Technologies such as 3D rendering, distributed processing and databases, and intelligent agents need to be "plug and play" add-on components. This architecture should be sufficiently flexible to handle current requirements, future technologies, and unforeseen enhancements. The resultant C2 workstation built upon this architecture should be configurable for function (aviation vs. maneuver vs. air defense, etc.) as well as echelon (company to joint).

The architecture must incorporate the special near real-time needs of digital battlespace data. Data is being used to generate 3D fly- throughs of a battlespace and include imagery, elevation, cultural, and natural features. Object-based techniques are required for minimizing computer disk space required for storage of these types of data, as well as quick and efficient retrieval of data for near real- time rendering of 3D environments. Provisions must be made for updates to all types of data.

Furthermore, the architecture must accommodate intelligent agents distributed across the digital battlefield. These agents would include soldier generated and controlled as well as autonomous agents. Digital Battlefield Agents will allow collaboration through seamless integration of data; they will provide: plan de-confliction, data gathering and filtering (fusion), event triggers and alarms, and recommendations at all echelons including joint. An object-based infrastructure for the execution of these agents needs to be defined. The agent objects themselves need to be categorized and described. This description should include I/O, configurable parameters, purpose, and features, including learning abilities and behaviors.

The architecture, objects, algorithms and data structures developed will be used to create a next-generation, re-configurable object-based C2 visualization workstation. This prototype will be demonstrated on CECOM's Distributed Integrated Laboratory (DIL), supporting collaboration across CECOM labs and other Government and Industry facilities.

PHASE I: The first phase of this effort will focus on the definition of objects, hierarchies, and relationships required for a re-configurable C2 workstation. The objects defined will form the basis for a C2 workstation architecture to be prototyped in Phase II. Objects definitions will address current C2 functional needs, but focus on leading-edge technologies such as the efficient storage and retrieval of battlespace data, and incorporation of distributed intelligent agents.

PHASE II: In Phase II, a prototype of the proposed C2 workstation architecture will be developed. This architecture will include at least one thread of execution showing full functionality, a battlespace data management object, and will be integrated with at least one interface agent. The battlespace data management object will include sufficient capability such that it's performance can be benchmarked. The architecture should support some form of collaboration through the implemented agent. Collaboration will be demonstrated on CECOM's DIL.

PHASE III DUAL USE APPLICATIONS: The object-based architecture developed for this effort will be suitable for any environment where various functions are performed in parallel and at increased levels of detail. Examples include law enforcement, distribution, and manufacturing. Object-based storage and retrieval of battlespace data are directly applicable to all Geographic Information Systems (GIS), and is required for near real-time presentation of 3D environments. The implementation of object-based design in time- and space-critical applications is a new area, and needs to be addressed. GIS's are used in natural resource exploration; urban, suburban, and rural planning; farming; and scientific research.

The commercial applications of agent technologies are directly applicable to all sectors which require planning, scheduling, and collaborative work. Agent-based, distributed applications will become the technology breakthrough which move the Internet from merely an information retrieval system to a distributed computing environment which could enhance productivity and improves decision-making on a global scale.

A97-057 TITLE: Continuous Microoptical Surface Profile Etching in InSb and InAs to Provide High-Efficiency, Low-Cost Microoptical Components

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop and demonstrate new and innovative processes for continuous etching of microoptic surface profiles in infrared transmitting semiconductor materials (InSb, InAs).

DESCRIPTION: Microoptics for infrared transmitting semiconductors such as InSb and InAs are required for advanced staring FLIR systems. The advanced microoptic surfacing processes developed under this topic would provide high optical efficiency and low-cost production through a single mask-and-etch process. Currently, microoptics are produced through a binary multi-mask-and-etch process that is time-consuming, costly, and alignment-sensitive and results in a surface that is at best a binary approximation of the desired surface profile. This binary approximation reduces the efficiency of the microoptic. A new gray scale single mask-continuous surfacing technique would reduce the number of steps, reduce the number of masks, and produce the actual desired surface profile. This technique is being developed for standard optical materials, however, not for Infrared transmitting semiconductors. It is therefore desired under this topic to develop processes for single gray scale mask-continuous surface profile microoptics for InSb, InAs.

PHASE I: Investigate new and innovative processes for continuous microoptical surface profile etching in infrared transmitting semiconductors to provide high-efficiency, low-cost microoptical components for staring FLIR systems. Single gray scale mask-and- etch processes shall be developed to reduce cost and provide continuous profiles for high efficiency. Prototypes shall be tested for performance and for efficiency improvements over standard binary methods.

PHASE II: Implement new continuous profile microoptical components into staring FLIR systems to test for imaging and microoptical performance. Laboratory and/or field testing against system specifications shall be accomplished along with imaging system performance measurements such as MRT and MTF.

PHASE III DUAL USE APPLICATIONS: Processes developed under this topic would have application to the commercial FLIR, IR detector, and micro- manufacturing industries. For example micro-lenses produced with this method would have higher efficiency than those produced by binary methods and could be used to provide higher fill factors, reduced noise, and reduced radiation sensitivity for detectors. Also, the continuous profiling process will reduce production costs, making microoptics more attractive for commercial uses.

A97-058 TITLE: Intelligent Power Management and Distribution System for Shelters and Vehicles

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop a smart, configurable, and adaptable power management and distribution system for use in shelters and ground vehicles. The system should reduce workload for the troops, improve power distribution performance, and integrate power management as a compatible system for "plug and play" type operation.

DESCRIPTION: Increasing electric power requirements for support of modern electronic battlefield are placing ever increasing demands on electrical power support systems. This is applicable to both mobile and fixed shelters and ground vehicles used to support theaters of operation. A smart system, capable of load scheduling, and adaptation to new load configurations is required. It should be reconfigurable to respond to faults or power interruptions resulting from battle damage. Advanced operating protocols would ensure sufficient electrical power at crucial times during engagements. Smart systems with advanced control algorithms are required for automatic reconfiguration under abnormal conditions. Moreover, autonomous operation will reduce support manpower requirements, allowing troops to focus on mission objectives.

Load scheduling should be integrated in the system to provide prioritization of power requirements during different operations, shifts, and status. State-of-the-art power semiconductor power controllers should be used. These must provide normal power switching control, in addition to wiring and circuit protection. They will replace traditional electromechanical power control relays and thermal circuit breakers. Solid state power semiconductors offer significant improvements in reliability, especially in harsh field operating environments.

PHASE I: The contractor shall define the power management and distribution system to include: Development of the system electrical architecture, generation of top-level operating protocols and control definition, and development of detailed electrical designs (validated with computer simulations where applicable). In addition, during Phase I, the contractor shall demonstrate the implementation of the power controllers to be used on this project. The contractor shall also develop technical packaging concepts, and perform thermal design and analysis to validate the approach.

PHASE II: The contractor shall complete detailed electrical and mechanical designs and operating codes and algorithms. The contractor shall then fabricate a full-power prototype and demonstrate its design robustness, functions, and features.

PHASE III DUAL USE APPLICATIONS: Buildings where load scheduling is required in place of expensive refurbishing of distribution wiring. It could be used in temporary shelters such as those deployed for disaster relief operations or at construction sites. The smart power distribution system developed here could be used in hospitals, police stations, etc.

A97-059 TITLE: Knowledge-Based Doctrine Tool

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: Develop a tool to parse, analyze and generate affiliation/competition sensitive tactics, techniques and procedures in accordance with given documented enterprise concepts, missions, policies and strategies.

DESCRIPTION: Military and civilian Government organizations and commercial enterprises publish their mission and plans, policies and strategies. Large organizations such as the military also publish training material such as field manuals and technical manuals describing their tactics, techniques and procedures. Much of this documented material can be a valuable reference source and a starting point for defining a knowledge based repository of the doctrine for the enterprise C2 decision-aids and C2 Systems.

PHASE I: The Phase I effort will focus on how knowledge-based doctrine may be gathered and extracted intelligently from a wide variety of sources such as operational plans, training manuals, educational texts and computer-based simulations. A low cost storyboard prototype will be designed to demonstrate supported knowledge based representations, and tools for their analyses and syntheses. Any extracted or generated knowledge must be exportable or importable in standard multimedia formats (Text and Graphics) consistent with office automation and computer based training (CBT) tools.

PHASE II: The Phase II will develop the infrastructure for the integrated office automation/authorware CBT knowledge-base tool demonstrating its operational capabilities and utility in conjunction with Government furnished sources.

PHASE III DUAL USE APPLICATIONS: Commercial enterprises require automated decision support tools which are kept up to date with their evolving missions and training tools. Just like DoD, many companies are known to be developing Computer-Based Training (CPT) which they would like to reflect their philosophy, policies, strategies, tactics, techniques and procedures. A single repository for their doctrine, i.e., the embodiment of techniques and procedures reflecting and consistent with their policies, strategies, and tactics, would ensure that training is consistent with operational usage.

A97-060 TITLE: Closed Loop Position Updates for Low-Cost Inertial Systems

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: There is a need to develop low-cost inertial navigation systems to augment GPS through periods of signal loss. The dismounted soldier cannot rely solely on GPS for determination of position. For example, the GPS signal has limited availability in forested and urban areas, as well as in buildings and tunnels. The ability to return to a previously visited spot is a navigational resource that could be used by a dismounted soldier. We wish to determine the extent to which this process can be used to reduce the growth of inertial navigation error and thereby increase the endurance and reduce the cost of inertial navigation sensors.

DESCRIPTION: Analytical studies would be conducted to determine processes to maximize the benefit of returning to previously visited locations and computing position and velocity corrections to the inertial navigation system. The process should yield the ability to reset the error growth since the prior visit. Additionally, if there is a stop, then a zero velocity reset could be executed for the inertial system. Following the analytical investigation, a simulation study would be conducted to evaluate the practical utility of the proposed processes and algorithms.

PHASE I: Conduct the analytical and simulation efforts described above.

PHASE II: Assemble a prototype low-cost inertial navigation system using state-of-the-art low-cost inertial components and evaluate the value of the developed processes in a Military Operation in Urban Terrain (MOUT) exercise.

PHASE III DUAL USE APPLICATIONS: There is a market for inertial navigation augmentation for GPS navigation systems. This includes DoT efforts for GPS-based navigation systems for trains, buses, trucks, and the Intelligent Highway program. Recently, DoA has sponsored efforts on navigation and guidance for farm tractors.

A97-061 TITLE: Flexure Springs/Pulse Tubes for Linear Drive Cooler Applications

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Design, fabricate, and demonstrate the use of Flexure Springs and Pulse Tubes as replacement components for existing compression springs and regenerators currently used in linear drive coolers. The Flexure Springs would eliminate all side loading and incidental contact of the compressor clearance seals, reduce assembly time, and compressor vibration, while the Pulse Tube would eliminate all vibration associated with existing moving regenerators. These two improvements could increase the Mean Time to Failure (MTTF) life of linear drive coolers from 4000 hours to 10,000 hours and reduce the cost by approximately 20%. They would be used in all future systems employing linear drive coolers and could be retrofitted in all fielded SADAs.

DESCRIPTION: The Army needs linear drive coolers that will last for 10,000 hours MTTF for both present and future applications. Presently, all tactical linear drive coolers are assembled using compression springs to control the linear motion of dual-opposed clearance seals. This type of spring, by design, has a torque associated with it as it undergoes compression and expansion, thereby causing some misalignment of the moving clearance seals. This misalignment causes the clearance seal to contact the piston sleeve, resulting in seal wear leading to seal wear out and ultimately cooler failure. The Flexure Springs will maintain perfect alignment after assembly and will not cause side loading since no torque is present. Misalignment and incidental contact will be eliminated, thereby eliminating seal wear and eventual cooler failure. This design would be more robust, easier to assemble, and will have reduced vibration output. Requirements for present airborne and target acquisition systems call for stabilization to 15 milliradians. Existing linear drive coolers utilizing undamped moving regenerators do not meet these requirements, and would only do so through use of costly complex counterbalances possibly with active controls. Although signal output sensitivity has decreased from 1st- to 2nd-generation thermal imaging systems, there is still concern about cooler-induced noise caused by vibration along the coldfinger axis, introducing microphonics. The introduction of Pulse Tubes will eliminate the clearance seal in the coldfinger, the moving mass of the regenerator, and greatly reduce vibration associated with the current design.

PHASE I: Investigate the mechanical design and physical configuration of Flexure Springs and their ability to meet the requirements for existing linear drive cooler applications. Investigate the thermodynamic design and physical configuration of the Pulse Tube and its ability to meet requirements for SADA applications. Design the Flexure Springs to meet physical and performance requirements for linear drive coolers. Design Pulse Tubes to project performance characteristics when it is coupled to a linear drive cooler and its ability to be configured to fit in a SADA coldfinger.

PHASE II: During Phase II Flexure Springs and Pulse Tubes will be fabricated, assembled and tested in a one watt linear (OWL) drive cooler, a 1.75 watt linear drive cooler and a JAVELIN linear drive cooler. The performance of these components would then be evaluated in their ability to meet the OWL , 1.75 watt and JAVELIN cooler as well as SADA requirements.

PHASE III DUAL USE APPLICATIONS: Stabilized Linear drive coolers have numerous commercial applications, including thermal imaging systems used by border patrols, physical security, failure detection, plant/building inspections, law enforcement agencies, and drug interdiction forces.

A97-062 TITLE: Development of Affordable Multi-Spectral Windows

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To investigate, develop, and demonstrate the feasibility of fabricating affordable Multi-spectral windows for use with boresighted FLIR sensors, visible cameras, laser-based rangefinders, and laser designators.

DESCRIPTION: Current military and commercial surveillance systems composed of multiple sensors which operate at different wavelengths, require the use of multiple spectral windows. The multiplicity of windows adds to the weight and size of multi-spectral sensor suites. A single window with multi-spectral capabilities would lead to smaller and lighter sensor packages.

The windows are required to protect delicate, high-performance sensors against weather effects and flying debris, when these sensors are mounted in helicopters or ground vehicles. For example, these windows are required to provide anti-fogging and defrosting capabilities to maximize sensor performance. The windows shall operate in the following wavelengths: 0.4-0.8 ìm, 3-5 ìm, 8-12 ìm, 1.06 ìm and 1.54 ìm.

Currently, spectral windows meeting all the above requirements are expensive, and cost more than the sensors being protected. We seek the development and demonstration of an affordable multi-spectral window for use in sensor pods mounted on airborne and ground vehicles.

PHASE I: Identify materials, manufacturing processes, assembly techniques, and design features to produce affordable (low-cost) multi-spectral windows. Cost drivers (materials, manufacturing processes, labor, etc.) may be identified through a Pareto analysis or other appropriate analytical tools. A tradeoff analysis with respect to design, cost, and performance should also be provided. Report on the results of the investigation and analysis.

PHASE II: Design, build, test, and demonstrate a prototype multi- spectral window based on the best Phase I design. A final report should be provided documenting the performance. A cost analysis should be provided based on production of 500 windows.

PHASE III DUAL USE APPLICATIONS: Commercial surveillance systems for use in law enforcement, maritime surveillance, and airport security systems.

A97-063 TITLE: Donor-Transparent System Data Interface

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Development of an interface between a donor computer system and a user to allow the user to exchange data with the donor system without modifying the donor system's software.

DESCRIPTION: Fielded systems and their simulators are very useful tools for training and concept validation. Data collected from field or simulator sources can also be used to validate systems undergoing development. In general, data elements can be captured during the execution cycle of a simulator or operation of a field system. For instance, JANUS is a constrictive, statistically-driven battle simulator. Communication with JANUS is currently limited to a Local Area Network (LAN) and required information is manually entered using dedicated terminals. One way to capture data is from a monitoring node (terminal) residing on the LAN, thus requiring no software modification for the donor system. This direct interface between the peripheral system and JANUS would allow remote system participation.

PHASE I: Define interface problems, generate solutions, and define the overall architecture of the required system interface. An architecture similar to JANUS may be studied so as to facilitate data embedding and access. Test the conceptual approach.

PHASE II: Develop a functional interface between the simulator and a system where an exchange of data between JANUS and a test system will take place.

PHASE III DUAL USE APPLICATIONS: Data captured during operation of a simulator or fielded system would significantly impact testing, improvement, and development of computer-based systems in industry. A filter-driver can be used in conjunction with the captured data to provide test stimuli for a system to accelerate its development and ultimately to improve the final product. The saving are especially significant if the human factor is the major element in the system under evaluation.

U.S. Army Edgewood Research, Development and Engineering Center (ERDEC)

A97-064 TITLE: Frequency Domain Imaging Sensor for Enhanced Stand-off Chemical Detection

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Build an Etalon Imaging System for Enhanced Standoff Chemical Detection.

DESCRIPTION: Chemical agent infrared absorption/emission is largely confined to the 8 to 10 micron region of the EM spectrum. Novel nanotechnologies employing PZT stacks facilitate the movement of a set of parallel mirrors (an etalon) with nanometer (or better) resolution. Thus it is now feasible to design and construct an etalon with a gap adjustable between 8 and 12 microns with high resolution, which would be ideal as a passive or active stand-off chemical agent detector. The device would perform as a Fabry-Perot interferometer, a well- established and proven technology. As the etalon gap is moved, only IR radiation with wavelength precisely matching the gap will pass and hit the detector. The etalon imaging system would have a number of advantages over a conventional FTIR interferometer: 1) it would monitor very sharp lines, increasing resolution and thereby noise, 2) it would contain no mechanical moving parts, making it inherently rugged and precise, 3) it would directly measure spectra, dramatically reducing data sampling rate while enhancing spectral throughput (spectra could be acquired at about 4kHz), and 4) it would have a large dynamic range. Furthermore, the system would be compact and thus easily integrated into a variety of configurations. This system would directly support the Army's Chemical Imaging Program, which has been identified as a far-term need in the DoD Joint Detection Program Strategy as defined by the Joint Panel for Chemical and Biological Defense.

PHASE I: Demonstrate laboratory scale proof-of-concept, including the design of a laboratory etalon with one detector.

PHASE II: Build and test the Phase I laboratory scale etalon. The testing would include etalon performance and measured spectra. Design of a prototype field testable etalon would evolve from the tests on the lab instrument.

PHASE III DUAL USE APPLICATIONS: Applications range from research spectrometers to atmospheric monitoring devices.

U.S. Army Missile Command (MICOM)

A97-065 TITLE: Integral Missile Seeker Signal Processor Design, Development, and Implementation

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: The Army Missile Command's Research Development and Engineering Center is pursuing the development of an integral upgradeable missile seeker signal processor. It is desired to provide advanced functionality while allowing future functional improvements and near-term cost effectiveness.

DESCRIPTION: The contractor shall analyze the current methods for embedded signal processor design taking full advantage of all commercially available tools and those developed under Government funding, such as in the Rapid Prototyping of Application Specific Signal Processors (RASSP) program. The goal is to design an integrated missile seeker signal processor.

PHASE I: Evaluate current design methods and tools. Select a tool set which provides for all levels of design, from the highest functional block diagram to circuit board(s) layout and fabrication. In addition, the tool set must incorporate the system requirements for built-in testing, timing, and system constraints such as size, weight, and power to aid in component and process selection, and architecture definition. The tool set should also incorporate a hardware/software mapping tradeoff analysis capability and hardware/software tradeoff optimization. The contractor shall define an architecture using the selected tools which allows for future upgrades at an incremental cost when advanced processing components become available and also help in defining the requirements for these new components that is necessary before upgrading is appropriate or can reasonably be accomplished. The contractor shall implement a design incorporating signal/image preprocessing, automatic target recognition/acquisition, tracking, reacquisition, aimpoint selection, and prototype based on autopilot functionality.

PHASE II: Fabricate and demonstrate the Phase I design.

PHASE III DUAL USE APPLICATIONS: There are significant potential commercial uses for the technology developed under this SBIR scope of work title. Some of the commercial uses are design of embedded processors for surveillance systems and robotics.

A97-066 TITLE: High-Speed, Precise, "No Moving Parts" Scanner for Use in a Compact Eyesafe Ladar

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop a high-speed, accurate, agile solid state scanning device, with no moving parts, of reduced size and mass compared to current mechanical laser scanners.

DESCRIPTION: Currently, most laser scanning systems are mechanical. These systems use a motor to rotate a prism mirror or use a gimbaled system. These mechanical systems are relatively large. A solid state scanner with no moving parts will offer a smaller and more compact laser scanning system. There is a need for a scanner that is small (clear aperture of 7.5 cm), accurate (pointing resolution of 0.4 mrad), and agile (< 100 msec response time, > 50% transmission over a 30 x 30 degree field-of-regard). The anticipated laser source would operate at 1.54 microns, with a total beam energy of 250 mJ per 8 nsec pulse.

Some examples of possible technologies that could be considered are, but are not limited to, ferroelectric liquid crystal (FLC), optic waveguides, and electro-optically activated Bragg transmission gratings.

PHASE I: Define a scanner design that will meet the performance goals stated in the description. The research and study shall determine and include the following: A conceptual design based upon the findings, growth potential, risk factors and their relevance, performance of the system and a final report detailing the factors determined with supporting rationale.

PHASE II: Phase II should be the construction of the solid state scanner designed in phase I. This scanner should be tested to see that it meets the performance goals of the Phase I design. All hardware, design layout, documentation, and test data shall be delivered to MICOM RDEC upon completion.

PHASE III DUAL USE APPLICATIONS: There are several commercial applications for a miniature, high speed, "no moving parts" scanner. These applications range from laser range finders to entertainment systems. Laser engraving, laser printers, and copy machines are also other possibilities. This topic is also directly related to a MICOM RDEC, small submunition, ladar seeker, in-house development called HIgh QUantity Anti Material Submunition (HI-QUAMS). HI-QUAMS was favorably briefed to the Ft. Sill Battle Labs & Directorate of Combat Development and it has also been briefed to the Secretary of the Army for Research, Development and Acquisition office without exception.

A97-067 TITLE: Multiple Channel GHz Sample Rate Pulse Capture Module Development with Integrated InGaAs Detector Array

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: To develop materials, devices, and packaging techniques that allow for high-speed analog-to-digital converters, trigger/timing circuitry and memory buffers to be packaged into a single module with an integrated detector array suitable for eye-safe laser radar sensors in missile applications.

DESCRIPTION: Compact imaging laser radar will likely have a key role in future autonomous systems from unmanned vehicle navigation to missile guidance due to the high resolution three-dimensional images that can be achieved. A critical aspect in realizing high resolution range information is precise characterization of the laser pulse return signal. To achieve less than 0.4 meter range resolution presumed necessary for reliable automatic target recognition (ATR), sub-nanosecond timing resolution is required. When laser pulse width is substantially greater than desired timing resolution, sophisticated signal processing is generally required. Additionally, in achieving sufficient peak power and narrow pulse width for high probability of detection and accurate range measurement, a compromise in laser pulse repetition frequency (PRF) is generally necessary. A low PRF limits the scan rate and area of coverage for an imaging ladar. To increase the area of coverage for a given scan rate, laser beam splitting and multiple receivers are typically used.

Digital technology makes possible highly sophisticated signal processing functions that lead to more accurate results than achievable with analog methods, but a lack of high-speed analog-to- digital (A/D) converters has restricted the use of digital processing in wide bandwidth applications. Recent advances in the development of gallium arsenide (GaAs) integrated circuit (IC) technology has led to A/D converters operating with greater than GHz sample rates. Examples of GaAs IC technologies which have demonstrated GHz sample rate A/D converters are: metal semiconductor field-effect transistor (MESFET), high electron mobility transistor (HEMT) and hetero-junction bipolar transistor (HBT) semiconductor technologies.

To make use of digital processing in a compact imaging laser radar system, there is a need to develop technology suitable for packaging a multiple channel pulse capture module consisting of A/D converter, trigger/timing circuitry, and memory buffer for each receiver channel. For a missile application, it would be advantageous to integrate the laser detector for each channel within the electronics module. To that end, indium gallium arsenide (InGaAs) detectors are suggested for consideration, expecting that future laser systems will operate at eyesafe wavelengths greater than 1.4 microns. The objective of this development effort is to demonstrate such technology with the following performance goals:

-- five to ten receiver channels

-- 500 MHz bandpass per channel
-- one GHz sample rate per channel
-- six to eight bits resolution per channel
-- 256 word memory buffer per channel
-- 7.5 cm x 7.5 cm x 2.5 cm package (not including power supply)

PHASE I: Examine material combinations, architectures, and processes for (as primary objective) constructing multiple high- speed analog-to-digital converters, trigger/timing circuitry, memory buffers, and (as secondary objective) integrated InGaAs detector array, with an emphasis placed on compact packaging. Identify candidate configurations, and perform trade studies to determine feasibility of each configuration identified. Propose a practical design for integrated pulse capture electronics and detector array which addresses the compact volume objective and performance goals. Provide a detailed analysis/simulation to support the proposed design.

PHASE II: Develop the integrated pulse capture electronics and detector array module designed in Phase I, and fabricate a testable prototype. Test the device to stated performance objectives. Analyze the electrical noise characteristics, electrical power requirements, and cost drivers in fabrication process. Identify areas for performance enhancement, and fabrication cost reduction.

PHASE III DUAL USE APPLICATIONS: The integrated pulse capture electronics and InGaAs detector array module developed under this SBIR effort would demonstrate enabling technology leading to availability of high resolution sensors presently restricted by eye safety issues associated with current solid state laser technology. Small light weight laser based sensors distinctly have both military and commercial applications including: range finding, remote sensing, and imaging laser radar. This topic is also directly related to a MICOM RDEC, small submunition, ladar seeker, in-house development called HIgh QUantity Anti Material Submunition (HI-QUAMS). HI-QUAMS was favorably briefed to the FT. Sill Battle Labs & Directorate of Combat Development and it has also been briefed to the Sec. of Army Research, Development and Acquisition Technology office without exception.

A97-068 TITLE: Application of Epitaxial Liftoff (ELO) Technology to Microelectromechanical Systems

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop system concepts and manufacturing processes which combine MEMS and ELO technologies for advanced optoelectronic/microelectromechanical applications.

DESCRIPTION: Advances in MEMS technology promise sensing and actuation capabilities at device geometrics measured in microns. Using fabrication techniques similar to those in the microelectronics industry, mechanical, optical, and electronic functions can be combined on a substrate in large volumes, promising high-performance low-cost multi-function subsystems. ELO processing technology allows semiconductors fabricated on a growth substrate to be lifted off and transferred (grafted) onto an alternative host substrate of nearly any material composition. The main advantage of ELO is the capability to bond devices usually incompatible with silicon processing to an integrated circuit as if the devices had been grown as part of the circuit. The combined MEMS and ELO technologies offer potentially large increases in functionality, performance, and integration by allowing process-incompatible materials to be hybridized in a semi- monolithic fashion. An application such as a low-mass, high data rate, intelligent optical disk read/write head could be designed using lifted-off vertical cavity surface emitting lasers (VCSELS), thin film detectors, and MEMS micro-positioners grafted onto CMOS processing chips. Other potential applications include active optical alignment, potentially higher-accuracy inertial devices and chemical sensors, and generally greater processing capabilities by grafting MEMS devices to CMOS processors. Development is needed, however, in device electrical connectivity, planarization, materials and processing compatibility, thermal management, 3D electrical-mechanical-optical-thermal modeling/design, and pre/post-processing of devices.

PHASE I: Determine functions of MEMS that can be uniquely modified or enhanced by applying ELO processes and ELO devices. Examine fabrication scenarios for grafting thin-film electronic and optoelectronic devices onto MEMS devices/substrates, and grafting MEMS devices to CMOS processors. Determine materials, processing, and fabrication requirements and incompatibilities for ELO/MEMS component fabrication. Design and propose demonstration devices and subsystems that can be fabricated using current/slightly modified techniques. Develop elementary model of demonstration device and provide input hooks for empirical data. Fabricate and functionally test one demonstration device, combining ELO techniques with MEMS devices.

PHASE II: Develop processing and fabrication techniques for the highest payoff applications. Demonstrate the improved processes for one or more applications. Environmentally test fabricated devices for robustness. Update and improve elementary model with test data input and more advanced techniques. Develop "roadmap" Enhance and harden processes to increase reliability, repeatability, yields, and lower cost.

PHASE III DUAL USE APPLICATIONS: Forecasts for MEMS-based products predict a $12 billion market by the year 2000. Much of this market will center on MEMS products used as sub-components for commercial products such as automobiles,

printers, and mass data storage and telecommunications devices. The commercial market will drive the availability and cost of MEMS and ELO-enhanced MEMS devices. Any improvements in performance, functionality, and cost brought about by skillfully combining the two technologies can only increase market projections, leading to ever more affordable off-the-shelf technology for military use.

A97-069 TITLE: Low Cost Tactical Pintle Motor Test Bed

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: To develop a pintle motor performance computer model, and a low-cost test method to verify the model and to evaluate tactical- sized pintle motor configurations.

DESCRIPTION: Smart propulsion is being investigated as a next- generation solution to the propulsion problems facing the missile community today. Pintle-controlled solid propulsion will qualify as smart propulsion by providing a mechanism to provide variable thrust upon demand to ultimately enhance the performance of the missile. Pintle motors may be used to provide this thrust control by combining a pintle with a nozzle to vary the nozzle throat area, and by using solid propellants with high pressure exponents to facilitate large changes in chamber pressure with small changes in nozzle throat area. Through the use of advanced control mechanisms and a closed-loop control system operating off motor pressure, the pintle can be controlled to a degree such that thrust can be varied on demand. The internal motor chamber environment, particularly hot gases combined with particle impingement on the pintle, make pintle material selection a critical design consideration. Other pintle material considerations include low weight (most important for tactical applications) and low cost. Pintle geometry greatly affects motor operation and therefore thrust control. A method is sought to accurately model the flow in a solid propellant rocket motor with an imbedded axial (in-line) pintle, along with a low-cost method to verify the model and to test various pintle configurations. The model should be user-friendly and allow easy input of changes to pintle geometries to predict effects on gas flows and motor performance. Accurate prediction of gas flows should allow the motor designer to design the pintle geometry to maximize internal gas flows and thereby motor performance. To validate the model, the test bed should be a heavy-walled, hot gas vehicle for evaluating various pintle configurations, capable of withstanding internal pressures up to 10,000 psi. It should be modular to allow for easy interchanging pintles, nozzles, igniters, propellant grains, control mechanisms, and pintle attachment mechanisms. This will facilitate understanding the effects of changing these components on motor performance. The test bed should be of a tactical size for tactical missile applications.

PHASE I: Develop a model for the flow occurring in a solid propellant rocket motor with an imbedded axial pintle nozzle. This model should predict gas flow around the pintle and aerodynamic loads on the pintle. The model should allow for evaluation of various pintle configurations, including, but not limited to, pintle/nozzle geometry, pintle materials, pintle structural attachment configurations, and pintle movement. To verify the acceptability of the model, it shall subjected to independent evaluation and assessment by the government. To support this evaluation, all required hardware (including a Pentium or higher based computer) and custom software (including source code) for the model shall be delivered to the Government.

PHASE II: Under Phase II the pintle gas flow model should be coupled with internal ballistics modeling to obtain a prediction of the motor's performance in terms of pressure, thrust, and efficiency. Also during Phase II, validation of the models shall be conducted via a low cost tactical pintle motor test bed that incorporates all the desired features. Changes to the model may be made based on results of tests conducted. The test bed/motor shall be designed, developed, and demonstrated during Phase II. Tests shall be conducted to demonstrate the modularity of the test bed, and to demonstrate the ability of the test bed to provide multiple, controllable thrust levels. Tests shall also be conducted demonstrating the ability to evaluate pintles of various materials, with performance, weight, and cost as a consideration. Vendor supplied cost quotes for pintle materials should be supplied to support the viability of low cost materials for pintle applications. The test bed, all required hardware (including pintles of various configurations and a control mechanism for the pintle), and all custom software, both for modeling pintle/motor performance and for control of the pintle (including all source codes) shall be delivered to the Government.

PHASE III DUAL USE APPLICATIONS: This test bed and computer model could be utilized by commercial propulsion developers for the design, analysis, and testing of smart propulsion systems.

A97-070 TITLE: Video Transmission in a Non-Line-of-Sight Environment

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Provide live video transmission from an autonomous platform to a commander in a rear-based operations center, including the capability to transmit in a non line-of-sight environment. This system enables surveillance of enemy positions (target acquisition), collection of battle damage assessment data, terrain evaluation (ingress and egress routes), and other aspects of mission planning.

DESCRIPTION: Advances in technology will be primarily in optical and communications engineering, specifically laser and other forms of wireless transmission. The technology developed under this topic will provide live video from an autonomous platform to a rear-based operations center by optically transmitting analog TV signals to an airborne platform such as a low earth-orbit satellite or an unmanned aerial vehicle, and re-transmitting to a ground-based station. The information received by the GBS could be transmitted by terrestrial link (i.e. Army Common User System or "combat net") to the tactical operations center to enhance the commander's situational awareness. Global Positioning System coordinates of the area under surveillance should be included in the transmission.

PHASE I: A system for transmitting video to an airborne platform and relaying to a ground-based station using optical technologies should be analyzed for feasibility taking into account power and bandwidth constraints. The cost and suitability of advanced optical components must also be considered. An analysis of other possible methods of transmitting information in a non line-of- sight environment particularly radio frequency (RF) methods (including spread spectrum, a type of RF modulation for secure communications) should be provided for comparison.

PHASE II: The research effort will concentrate on transmitting video and derived imagery using the least amount of resources (power, bandwidth, etc.) to an airborne platform and re- broadcasted to a ground based station. This effort will leverage off advances in optical technologies and digital signal processing. The deliverable product (transmitter and receiver) will be a system of technologies that can be inserted into a warfighting experiment, specifically Concept Evaluation Program (formerly known as Battle Lab Warfighting Experiment), Advanced Technology Demonstration, or Advanced Warfighting Experiment. This experiment should include an autonomous vehicle transmitting video to an operator at a ground based station for purpose of steering the vehicle, and possibly a second channel dedicated to imagery collection. Note that the video signal may be a rudimentary analog TV signal whose exact form will be determined by the research effort. A secondary focus could be transmitting imagery derived from the video (received by the ground based station) via the combat network to a rear-based operations center using wireless modems or other wireless technologies. Note that Battle Command Battle Lab (Ft. Gordon, GA) has demonstrated the use of wireless modems on the battlefield, but only to transmit alphanumeric data over short distances. The above scenario is consistent with the "Remote Warfare Operations" Concept.

PHASE III DUAL USE APPLICATIONS: The potential commercial market includes law enforcement agencies for surveillance of potential criminal activities, visually monitoring environmental conditions such as river levels or snowpack in ski resorts (potential avalanches), hazardous waste site management, and search and rescue operations in complex terrain.

A97-071 TITLE: Scramjet Combustor Modeling

KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: Develop the methodology to simulate supersonic scramjet combustion.

DESCRIPTION: Advances have recently been made in the joint U.S./Japan Ducted Rocket Engine (DRE) program in inlet and combustor modeling and in predicting the performance of a ducted rocket airbreathing engine. This progress was made based on advances in coupling computational fluid dynamics (CFD) with chemical kinetics. The supersonic inlet for this engine was designed using advanced three-dimensional CFD capabilities and proven with wind tunnel validation and performance tests. The inlet and combustor interaction has been predicted, it has not been validated by testing; however, the modeling technique provides far-reaching capabilities that have not previously existed. A logical extension to this technology is to develop the capability to design and analyze supersonic combustion ramjets which have the capability to boost missile payloads to much higher velocities than can currently be achieved with DRE powered missile. To apply this technology to a scramjet it is necessary to develop a supersonic combustion mixing and kinetics model which can be added to current reacting flow CFD models applicable to subsonic combustion. The challenge is to develop a coupled reacting flow CFD/hypersonic inlet model wherein a non-equilibrium chemistry model is strongly coupled to the fluid dynamics model. This technology requires a turbulence-chemistry interaction model to accurately describe the mixing and combustion processes and to establish an ignition criterion.

Although CFD modeling techniques have been applied to scramjet combustion flowfields, the current approach is to use semi-empirical methods to determine an ignition criterion and the turbulence chemistry, interaction or turbulent chemistry, is usually ignored. Innovative improvements to capture both of these phenomena are critical to the determination of the utility and modeling efficiency of any supersonic combustion ramjet design.

PHASE I: This effort will concentrate on developing the coupled set of non-equilibrium chemical kinetics and multi-stream turbulent mixing relations. An innovative analytical model must be developed for the turbulence-chemistry interaction that is so important to this application. Additionally, an innovative ignition model must also be included. Both models must be based on first principles of physics rather than relying on a semi- empirical approach. The result of Phase I will be a delivered comprehensive analytical model for three-dimensional scramjets and examples to justify the theoretical basis for the model.

PHASE II: The comprehensive analytical model resulting from the Phase I effort will be finalized, documented, coded, and incorporated into an existing Government reacting flow Navier- Stokes computational fluid dynamics model to be exercised in an extensive validation effort. In addition, the computational fluid dynamics model will be coupled with appropriate heat transfer boundary conditions to model a complete missile flyout trajectory.

PHASE III DUAL USE APPLICATIONS: This technology is directly applicable to advanced propulsion techniques for commercial applications such as high speed supersonic transports and single-stage- to-orbit launch systems.

A97-072 TITLE: Development of Generic Lethality/Warhead Performance Model for Guided Missile Systems

KEY TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: To provide a generic computer-based graphical tool that links warhead and missile system performance to lethality calculations. This tool will allow trade-off studies on warhead type, warhead size, terminal angles, aimpoint, and missile dispersion. The emphasis should be placed on an easy-to-use design level tool that allows trade-off and optimization studies of a system of interest.

DESCRIPTION: The generic tool should be implemented in a modular form. Each module should address a particular topic. These topics should include, as a minimum, range target definition, warhead definition, warhead interaction (physics models), target vehicle definition, measure-of-performance definition, input, tabular output, graphical output.

It is desired that the tool be implemented on a Personal Computer. If the code is not implemented on a PC, an engineering workstation, such as Silicon Graphics, shall be the platform of choice. The code and its platform machine shall be provided at the end Phase II.

It is required that the tool be able to read data from the commercial Pro-Engineering and government-furnished BRL-CAD software packages. Input for Pro-Engineering is required, but not limited to, range target definitions. Input from BRL-CAD is required, but not limited to, target vehicle definitions.

It is required that the code shall include warhead/target interactions for tanks and armored vehicles. Other vehicles such as trucks, rocket launchers, missiles, and helicopters are desired. It is required that the code support kinetic energy penetrators, shape-charge jet, and explosively-formed projectile warheads. It is desired that a capability to model other warhead types, or combinations of warheads be provided. System upgrades may be utilized to provide the desired information.

PHASE I: Provide a document defining the code architecture, platform, interfacing, capabilities and implementation. A sample users menu and/or interface modules should be provided and demonstrated. A cost estimate and program plan for the Phase II code implementation effort shall be provided.

PHASE II: Develop the graphical tool on the platform recommended during Phase I. Changes recommended by the government shall be implemented. At the completion of Phase II the contractor shall provide the code, running on its primary platform, to the government.

PHASE III DUAL USE APPLICATIONS: The commercial market for this product is to provide the code, support, classes on its operation, and data upgrades. This would be made available to both Project Offices, RDEC staff, other government agencies and government contractors. With minor code modification this product could find direct application to the space industry for debris impacts on space vehicles and habitats. Further customization could be made for application in the petroleum industry, which has concerns with hypervelocity fluid impacts. Phase III award of this SBIR would provide a deliverable code, and its implementation, for project offices, other government agencies, and government contractors to purchase. By having the capability to conduct trade-off studies by varying warhead and terminal missile parameters through simulation, the DoD/Army will greatly reduce R&D expenditures by being able to accurately predict missile warhead performance. This tool may also be utilized as a means of defining missile specifications and requirements. Finally, a commonality between the project office, government contractor and RDEC staff would be established. Due to the interest of NASA and the petroleum industry in hypervelocity impacts and penetration effects, this code could be modified and customized for other specific concerns.

A97-073 TITLE: Programmable High Speed Large-Format CCD Camera

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: High speed, large format Charge Coupled Devices (CCDs) have numerous uses in image processing, surveillance, and reconnaissance applications. Such devices are also proving to be valuable tools in medical imaging and high speed event analysis. Ideally, such cameras would allow the user to trade-off speed for resolution as well.

DESCRIPTION: The ultimate goal of this effort is a 1024 x 1024, 12- bit CCD with a minimum 200 Hz frame rate. Additionally, the CCD should have 512 x 512 and 256 x 256 binning modes with 400 and 1000 Hz frame rates, respectively. A high-speed, on-board frame subtraction mode for motion or change detection is also a requirement.

PHASE I: Prototype an array capable of demonstrating binning modes and frame subtraction but would not achieve the stated frame rates. This would be a proof-of-concept demonstration.

PHASE II: The goal of Phase II is to build and demonstrate a full scale CCD array with binning and frame subtraction capabilities and desired frame rates as mentioned above. In addition, this CCD would be integrated into an optical correlator as either the input detector or the correlation plane detector.

PHASE III DUAL USE APPLICATIONS: This device would find application in both the commercial and military sectors. Motion detection is of definite interest in security applications. High speed inspection is a priority in assembly lines and in evaluating surveillance imagery. In addition, such a CCD could be used to record high speed events for later frame by frame analysis. Medical imaging applications would also benefit from such a device.

U.S. Army Natick Research, Development and Engineering Center (NRDEC)

A97-074 TITLE: Materials and Designs for High Expansion Ratio, Hybrid Shelters

KEY TECHNOLOGY AREA: Clothing, Textiles and Food

OBJECTIVE: Develop new, flexible, affordable materials for use in high expansion ratio, hybrid shelters.

DESCRIPTION: Soldier "Quality of Life" is a high concern for long term deployments of the U.S. Military. Soldier support systems such as FORCE PROVIDER and the Deployable Medical System (DEPMEDS) rely heavily on the Army's "TEMPER" tent; a 32-foot long, 20-foot wide frame supported tent. While this tent offers a cost-effective, highly deployable solution, the "quality of life" it provides for long term deployments is limited due to its lack of floor and soft-wall construction. The Air Force's Expandable Personnel Shelter (EXP) provided a point solution for this issue but its high cost and low durability of its expandable walls resulted in its demise. Research is required to develop a material suitable for use in a high expansion ratio hybrid shelter. The target expansion ratio is 12:1 with the rigid, shipping configuration being an 8'x8'x20' ISO shipping container. The concept is for an accordion-like expansion from each side of the shipping container, with a rigid flooring system suspended above the ground. The new material must be producible, affordable, and reliable, while possessing physical characteristics adequate for world-wide deployments (snow/wind loads, water-proof), environmental control (air-tight, insulative), and ease of deployment (light-weight, packaged in shipping container).

PHASE I: Investigate materials, material systems, and fabrication processes that may satisfy the stated objective. Candidate systems shall be prepared in bench-scale quantities for material property determination in order to rate their effectiveness as acceptable candidates. Final report will summarize all investigations and will provide an analysis and recommendation for the next phase of development.

PHASE II: Based on successful completion of Phase I, the contractor will design an expandable hybrid shelter in accordance with the stated objectives using the material (s) developed and recommended from Phase I. The shelter shall be fabricated and demonstrated to the Government with all findings and recommendations included in a final report.

PHASE III DUAL USE APPLICATIONS: Commercial tentage, architectural materials.

A97-075 TITLE: Glass-Embedded Polymeric Sheet Stock For Food Applications

KEY TECHNOLOGY AREA: Clothing, Textiles and Food

OBJECTIVE: To develop and produce a polymeric semi-rigid or rigid sheet stock material with a high-barrier embedded-glass structure capable of being thermoformed into a retortable food container (i.e., _-size steam table tray).

DESCRIPTION: The military need for a polymeric traycan is primarily to replace the present metal traycan. The metal traycan has a premium and expensive interior protective coating system. The can is heavy compared to a plastic can, difficult to dispose or recycle, difficult to open, and susceptible to coating failure. A glass-embedded/coated plastic can with a heat-sealable, easy-open lid will overcome these disadvantages while retaining the advantages.

Technology currently exists to coat plastic films with semi-flexible glass. The films are then fabricated into pouches that have been shown to provide foods with an extended shelf life. Technology also exists to post-coat extruded plastic bottles with high-barrier polymeric coatings to improve barrier and physical properties. Efforts are currently underway to post-coat a preformed traycan with a glass coating; however, while this might appear to be the most logical and feasible approach, it may not be the most cost-effective method. A more cost-effective and innovative approach not yet demonstrated would be to embed the sheet stock or coat it with a highly elastic glass structure prior to thermoforming it into food trays.

PHASE I: Phase I efforts will result in a method to embed/coat a flexible glass material into conventional polymeric sheet stock designed for thermoforming. The sheet stock will be capable of being thermoformed into food trays without losing the barrier properties provided by the embedded glass.

PHASE II: Phase II efforts will result in prototypes of food containers that were thermoformed from glass embedded sheet stock. Test data provided by the contractor on the physical, thermal and barrier properties of the thermoformed trays will verify the tray's ability to withstand rough handling, retort conditions, and sufficient barrier to provide food with a three year shelf life. The tray will be capable of being heat sealed with a glass-coated plastic film.

PHASE III DUAL USE APPLICATIONS: Dual use applications for glass- coated/embedded food containers are promising due to the lightweight, microwaveable and long shelf life features that makes it attractive for commercial usage. When compared to commercial 10 cylindrical cans, glass embedded/coated polymeric containers would have a narrower profile that would allow reduced processing time and a higher quality product. Glass embedded/coated polymeric trays may be thermoformed in any shape or size depending on market needs.

A97-076 TITLE: Residual Life Indicator (RLI)

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Develop an indicator to reside within a packaged chemical protective (CP) garment, and on a CP garment worn in a hostile environment, that displays the amount of CP protection remaining in the garment after exposure to warehouse fumes/organic vapors and chemical agents.

DESCRIPTION: The military has identified the need for a device that will monitor the performance of packaged CP garments stockpiled in government warehouses. Yearly agent testing of stockpiled items has shown that properly stored and packaged CP garments exhibited no loss in chemical protection when tested over the past ten years. Concern centers on failures to the packaging material, either through tears or pin-holes, which lead to contamination of the stored garment from warehouse fumes or other organic vapors. Current policy is to assume the CP garment within a damaged package has been compromised, and to destroy the garment rather than subject it to costly agent verification testing. To circumvent loss of potentially usable garments, it is proposed to develop an indicator for storage within the CP package which will visually display the degree of exposure to fumes/organic vapors and the resultant loss in chemical protection by the garment. Extension of this technology to a RLI that can be attached to CP garments for use in a hostile environment will follow.

PHASE I: Potential chemicals, polymers, or other innovative materials suitable for indicator use will be identified, with the most effective technologies selected for use alone or in combination in determining and displaying the degree of exposure to organic vapors/fumes and to chemical agents by a chemical protective garment when stored in a warehouse or worn in a threatening environment. Prevailing CP technology centers on the adsorbtive capabilities of activated carbon, which is finite in its adsorbtivity. However, other technologies (e.g., selectively permeable membranes) may be an alternative to activated carbon, so must be considered in selecting indicator materials. Small scale testing will be performed to demonstrate concept feasibility.

PHASE II: Phase I concepts exhibiting the most potential will be fabricated into prototype indicators for inclusion in a packaged CP garment, and performance tested by exposing the package to normal warehouse fumes and organic vapors and comparing the indicator display to an analytical evaluation of the CP garment for the amount of chemical protection remaining. Expansion of the most successful technology to include monitoring of chemical agent exposure by the indicator while residing on a CP garment in a hostile environment will be undertaken, and a prototype indicator fabricated and performance tested. The indicator design will be optimized for producibility and cost. Fifty units will be constructed for test and evaluation.

PHASE III DUAL USE APPLICATIONS: This technology is applicable to similar garments produced for use by other Government agencies, such as the FBI, or state/municipal police forces.

A97-077 TITLE: Development of Low-Cost Self-Sealing Chemical, Rain, Underwater Environmental Protective (E.P.) Closure System

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: To develop low cost chemical, rain, underwater environmental self-sealing closure system for use on E.P. uniforms/tentage/equipage.

DESCRIPTION: Current technology for closure systems used on E.P. items involves use of common zippers (plastic or metal), with zipper cover flaps which require hook-and-loop (Velcro) to retain the flap closed. However, neither the zipper nor the hook-and-loop possess any self-sealing capabilities and therefore offer potential for leakage in a contaminated environment. On the opposite end of the closure spectrum are self-sealing wet-suit zippers that can do the job except for two major factors: First is that they cost between $1 and $2 per inch; and secondly, they are stiff large bulky zippers that unfortunately cannot be miniaturized.

Overall requirements for proposed effort would be to provide capability to be produced in chain breaking strength of 145 lbs. minimum, offer 6 hours of continuing challenge to thickened GD (SOMAN Nerve Agent) in closed state, be hydrostatic resistant at 50 cm for 10 minute period, offer 5 pound (max.) slider resistance, and be available in either separating or non-separating configurations to engage/disengage uses a single slider.

PHASE I: Investigate potential technologies and processes for development of a self-sealing closure system. Develop and demonstrate one to three prototype systems for laboratory testing. Note: Methods such as filling the plastic coil zipper with melted butyl rubber solution, using a zip-lock type fastener with molded tooth configurations within their channels, and modification of the hidden type zipper (used on women's dresses) with a different type of zipper tape have been suggested possibilities.

PHASE II: Down-select and refine the best potential solution(s) from phase I. Produce a production quantity of self-sealing closure systems for laboratory testing and application into actual EP uniforms, tentage and equipage.

PHASE III DUAL USE APPLICATIONS: Closures to be used on commercial tentage, equipage, wet-suits, rainsuits, truck/boat covers, tarps, bags, etc. (anything to environmentally protect items).

U.S. Army Simulation, Training and Instrumentation Command (STRICOM)

A97-078 TITLE: Embedded Training Technologies

KEY TECHNOLOGY AREA: Manpower, Personnel and Training

OBJECTIVE: To develop new, innovative and cost effective technological solutions to support the Army's Science and Technology Objective for embedded training.

DESCRIPTION: Historically, the training community has used stand alone and networked simulators to train many of the tasks required to function effectively as a combined arms team. The primary limitations of these methods are that the equipment is not deployable and trainees must be transported to the training site. Because of the limitations, the Department of the Army needs to explore Embedded Training technologies to increase the effectiveness of its fighting forces.

There are many benefits of embedded training: (1) it will allow for mission rehearsal on site and on the trainee's actual equipment. This will alleviate the skills' decay problem that occurs as time elapses from the last simulator session; (2) it provides the recognition that the battlefields of tomorrow will consist of diverse enemies in a wide variety of terrain; and (3) it provides the opportunity to plan and train for newly developed situations - on relatively short notice.

The Army has placed renewed emphasis on embedded training capability as a result of the Gulf War. Through the INVEST STO (Science and Technology Objective), STRICOM will address the technological issues associated with delivering embedded training capability to the force. In short, it will concentrate on the architecture and standards which are required to successfully implement embedded training capability, focusing not only individual combat vehicles, but potentially involving multiple vehicles participating in a force-on-force exercise.

In summary, the goal of the INVEST STO program is to explore and enhance current embedded training systems technology. Optimizing this technology will permit continuous training, both at home station and while deployed, which will prevent critical skills from deteriorating. To this end interested parties should submit a proposal addressing any or all of the following areas. These areas appear in descending order of importance. Each proposal should clearly identify the specific area being addressed.

a. Development of architecture and design methodologies to incorporate embedded training capabilities into new start vehicles.
b. Identify durable and cost effective image generators for incorporation into the combat vehicle.
c. Provide the integration of virtual entities into the live field of view with a high degree of fidelity.
d. Control the training induced communications requirement so that it does not interfere with the tactical communication needs of the vehicle.
e. Identification of methods to isolate the training software/hardware from the operational program to ensure training capability does not have a negative impact on operational capability. Likewise, identification of methods to insure that live rounds and live systems are not inadvertently operated by the training software/hardware.
f. Conduct research into identification of what technologies can be applied in a cost effective manner to the embedded training requirements of the Army.
g. Develop concept and a prototype for the integration of virtual entities into the live field of view with correct visual occulting, and terrain registration.
h. Identify and prototype ruggedized and cost effective image generators suitable for incorporation into combat vehicles.

PHASE I: Explore concepts, methodologies, design possibilities in the above subject areas. Develop concepts for each of the relevant possibilities and show the feasibility for the concepts developed.

PHASE II: With the results of Phase 1, take the most promising concept, design or approach to develop and demonstrate the technology.

PHASE III DUAL USE APPLICATIONS: The proposed developments would have application in many commercial markets, including communications, instrumentation and training.

U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC)

A97-079 TITLE: Detection and Discrimination of Static and Dynamic Targets

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: To develop an analytic model of human observer response time and accuracy in target position and velocity estimation, as a function of the dynamic visual image.

DESCRIPTION: Many current human visual performance models predict detectability as a function of relative target/background characteristics. These computational models of early vision require high spatial and temporal resolution imagery as input data to calculate multi-resolution signature metrics. Additional statistical decision modules are employed to predict human performance for various target acquisition tasks and extend the front-end visual processing methodology, which has limited nowledge of the connection between early vision and cognition. In order to be more applicable to predicting human performance in a wider range of operational driving and military targeting tasks, the visual perception modeling needs to be further extended to include accuracy in locating targets and estimating distances and velocities. TARDEC is actively pursuing computational vision models for dual-use in virtual prototype simulations to (1) evaluate target signature/camouflage and acquisition technologies for military vehicles, and (2) evaluate warning and vision enhancement technologies in commercial vehicles for automotive safety. This project will extend TARDEC's current visual modeling and experimental capability and provide an important computational link between subject response and dynamic image information.

PHASE I: Description and specification of the analytic model of human observer accuracy and response time for locating a target and estimating its range and velocity.

PHASE II: Software implementing the model and data summarizing calibration and preliminary validation of the software.

PHASE III DUAL USE APPLICATIONS: Analytic models and data of human targeting and tracking performance for inclusion in military virtual prototype simulations of man-in-the-loop systems. Analytic models and data of driver's accuracy and response time in tracking other vehicles for inclusion in commercial virtual prototype simulations.

A97-080 TITLE: Tracked Electric Hybrid Propulsion Vehicle Design Code

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: Develop a software code that would allow engineers to design tracked vehicles using hybrid electric propulsion systems.

DESCRIPTION: Develop software that would allow engineers to conceptionally design tracked vehicles which use hybrid electric propulsion systems. The code shall concentrate on the issues of power
systems analysis. The analysis shall include but not exclusive to heat rejection, road loads, environmental, speed requirements, gradients, tracked steering, propulsion architecture, track configuration, component volume, and component weights. Vehicles shall include tracked and wheeled vehicles. Wheeled vehicles upwards of 2.5 tons shall be considered. Tracked vehicles in excess of 10 tons shall be considered. Code shall be capable of handling actual manufacturer specifications/databases of engine, fan, radiator, traction motors, power electronics, and other pertinent data required. Code shall be capable of running under Windows 95 environment. Also, allowances for geographical displays shall be made for commercial use.

PHASE I: Phase I shall focus on deriving and developing the physical equations and code architecture. The code shall be in FORTRAN 77 or 90. Code shall not include hardware specific subroutines. The work shall include the development of databases essential for developing a working code for tracked vehicles. Code shall be capable of output for current commercial graphical software for PC. Software shall be capable of using user input data for all calculations in addition to manufacturer specifications/database. Software shall include performance data from all major manufacturers of hybrid drive components for tracked vehicles. Thus, allowing designer to perform parametric sweeps for military tracked vehicles.

PHASE II: Work shall include presenting software in a graphical user interface. Software shall be capable of use as a standalone software. Software shall include performance data from all major manufactures of hybrid drive components for wheeled vehicles. Software shall be capable of presenting results in a graphical form. At the Phase II level the software shall be compatible for highway use designs of heavy wheeled vehicles. Thus, allowing designer to perform parametric sweeps for commercial highway and off road use vehicles.

PHASE III DUAL USE APPLICATIONS: At the Phase III level the software shall be compatible for all commercial automotive applications. Thus allowing designer to perform parametric sweeps for commercial highway use vehicles. Software shall allow hybrid car, truck and tracked vehicle designers examine mobilities requirement, compatible designs, and other feasibility requirements.

A97-081 TITLE: Intelligent Articulated Ground Vehicle Joint

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: The objective is to develop an intelligent articulated tracked/wheeled vehicle joint for improved off-road mobility and stability of manned and unmanned vehicles.

DESCRIPTION: Currently no single vehicle platform provides adequate mobility for the Robotic Reconnaissance, Surveillance, and Target Acquisition (RSTA) mission; however, by joining two chassis through powered hydraulic articulation it is believed that significantly higher mobility and stability will be achieved. Using a currently available tracked or wheeled chassis (e.g., HMMWV, MAK Weisel, or Hawk missile loader), develop a coupling and articulation mechanism between the two chassis. The design should consider the following issues: 1) Tracked vs. Wheeled vehicle Combinations; 2) Driven front chassis vs. Driven rear chassis vs. Both chassis driven; and 3) Automatic quick couple/decoupling of the independent chassis and control links between the chassis. The "intelligence" will address joint and vehicle dynamics, control, and any vehicle-to-vehicle communication. It will provide improved mission performance and survivability (trailer/vehicle towing, prevent overturning of vehicles on high grades or in slippery and wet conditions, rapid hill climbing and descending, enhanced sensor or weapon platform stability, etc.). Coupling and decoupling should be accomplished without operator intervention.

PHASE I: The contractor shall research and prove technologies, design and demonstrate the performance. Concepts shall be presented and substantiated through modeling and simulation. TACOM will evaluate and make a final decision of which concept to prototype.

PHASE II: The chosen prototype will be built and evaluated (TACOM will provide the base chassis to be articulated).

PHASE III DUAL USE APPLICATIONS: The military, as well as commercial market, has needs to traverse rough terrain that is impassable by current vehicles. Commercial applications of this technology are forestry, mining, and agriculture.

A97-082 TITLE: Advanced Ground Vehicle Propulsion Technology

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: To examine and develop technologies to increase power density with respect to volume and weight, increase efficiency, reduce specific heat rejection, and provide reliability improvement for high output military diesel engines.

DESCRIPTION: Anticipated future high output diesel engine operating conditions include cylinder heat loading greater then 4 horsepower (HP) per square inch (piston surface area), 4 cycle break mean effective pressure exceeding 300 psia, and brake specific heat rejection to coolant of 12 BTU per HP-Min or lower. Technology areas addressing these targets as well as that of reducing engine weight include, but are not limited to: 1) high temperature tribology (i.e., tribological system approaches should address high temperature lubricant capability, and friction and wear minimization in areas of borderline lubrication); 2) insulative componentry (i.e., components to be considered shall include pistons, rings, liners, valves, valve guides and seats, head or head combustion face and intake and exhaust ports and novel monolithic and coating applications for these components will be considered); 3) fuel injection system/ combustion enhancement (i.e., technologies to be considered include ultra-high pressure injection or other combustion technologies enabling diesel combustion toward stoichiometric conditions without fuel economy degradation, one particular interest for fuel metering is to compensate for different diesel outputs caused by various fuels, especially viscosity. A need exists for new systems as well as retrofit of army engines.); 4) high efficiency, broad range, low inertia and high tolerance to high exhaust pressure, and concepts to use a turbo alternator as a compounding unit are being considered for electric drive applications); and 5) engine lightweight structural concepts (i.e., requirement exists to provide dramatic weight reduction in diesel engine structure and componentry). Also concept designs presented shall he consistent with Army initiatives to reduce operating and support costs. Two generic cost drivers 1) causes of electrical/mechanical replacement costs and 2) causes of fuel/fuel distribution costs are directly applicable to this topic. It should be noted that the contractor may select component technologies supporting the above overall objective of the advanced diesel engine area. It is not expected that contractor should necessarily develop a technology system addressing all the areas discussed above.

PHASE I: The contractor shall research technologies and prove concepts from a feasibility standpoint. Concepts designs shall be presented and substantiated via analytical calculations, drawings or in the case of hardware for initial bench-type testing.

PHASE II: Concepts shall be demonstrated in Phase II using a single- or multi-cylinder engine with operating conditions similar to those of a high output military engine. Steady state as well as transient testing for 100 hours or more may be required.

PHASE III DUAL USE APPLICATIONS: Although commercial and military engines are of different power rating, the trend for commercial engines is also toward increasing high brake mean effective pressure end higher operating temperature. The engine area of interest presented are all generically applicable to future commercial diesel engines currently order consideration.

A97-083 TITLE: CORBA-Based Simulation and Data Security for Distributed Object Processing

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: The objective is to design and develop techniques that can ensure secure processing for distributed objects using the CORBA communication protocol.

DESCRIPTION: A baseline infrastructure, TACTICS, has been developed by TACOM, and enables the distributed interoperation of objects across networks. It is based on direct simulation-to-simulation interaction using CORBA protocols. An important aspect of expanding the services for both the Government and commercial sectors is that of simulation access security and data security. Suppliers of the simulations and computing assets have the need to control access to, and use of, these assets. The proposed effort will investigate the design and implementation of security measures using CORBA-based communication in the context of the TACTICS infrastructure. Work is ongoing with supercomputing assets as well as workstation computing platforms. This investigation will form the basis of security techniques that can be applied to accessing simulations and data within the CORBA communication framework.

PHASE I: The contractor shall research the feasibility of using the CORBA Security Specification and Architecture to provide the necessary access control to simulations and simulation data. A conceptual design will be developed that illustrates the use of the CORBA Security mechanisms and identifies what additional mechanisms may be need to provide adequate security and integrity for the simulation environment.

PHASE II: A prototype secure simulation will be demonstrated based on the conceptual design that includes the following security and integrity features: (1) Identification and authentication of all simulation users using strong authentication methods (i.e. not passwords), (2) Confidentiality and integrity of all simulation data that a user enters to protect it from other simulation users, and (3) Audit of all simulation activity identifying the user and the type of activity.

PHASE III DUAL USE APPLICATIONS: Security of paramount importance in many commercial applications where organizations need to protect access to their development efforts and product designs. With simulations providing an increasing part of product design, this effort will provide a basis for protecting information and simulation access in this object-based computing arena.

A97-084 TITLE: Acoustic Pattern Recognition

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop an acoustic pattern recognition system to provide detection/recognition/identification of acoustic signatures.

DESCRIPTION: Using acoustic signatures for target detection has some benefits over image-based systems, including non-line-of-sight detection and one-dimensional signal processing. The former allows one to see through buildings, hills, smoke and fog, while the latter provides simpler real-time processing. The ability to exploit acoustic signatures effectively is an important capability for any suite of sensors. TARDEC is pursuing innovative methods for acoustic pattern recognition, including multiresolution analysis, neural networks and fuzzy logic, for the purposes of target acquisition and vehicle design. This project will extend TARDEC s current acoustic signal processing capability and provide a real-time system implemented in hardware.

PHASE I: The contractor shall develop algorithms to perform acoustic signal detection/recognition/identification for near and/or long range acoustic signals. Nonstandard processing techniques (e.g. multiresolution analysis) should be benchmarked against standard methods (e.g. FFT). Algorithms must be implementable in a relatively inexpensive real-time system and tested on real ground vehicle acoustic signals.

PHASE II: Further refinement of algorithms to provide long and near range detection/recognition/identification for non-ideal acoustic signals. The system should include algorithms to reduce noise (e.g. from host vehicle and wind), incorporate atmospheric and seismic propagation and provide directional localization. Implement the system in hardware to provide real-time performance.

PHASE III DUAL USE APPLICATIONS: Acoustic algorithms of the type that would be developed for this system should have commercial marketability in the areas of machine condition monitoring, medical diagnostics (e.g. EEG, EKG), and voice recognition applications.

A97-085 TITLE: Front Seat Occupant Crash Protection in Ground Vehicles

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: To develop innovative occupant crash protection systems that reduce the frequency and severity of crash induced injuries to front seat Army personnel.

DESCRIPTION: Current occupant protection systems in Army ground vehicles have serious deficiencies which affect the safety of occupants in front seating positions. These deficiencies demonstrate a lack of system design necessary to protect the occupants in all foreseeable crash modes such as: frontal, side, rear, rollover, and wheels-down impacts. For example the following deficiencies have been noted in various ground vehicles:

The seat belt geometry in passenger front seating positions is hazardous. Poor geometry allows greater head and body excursion resulting in more frequent and severe impact injuries.

The seats do not incorporate an effective seat ramp to control pelvis motion during frontal collisions. This lack of pelvic control can result in severe injury in frontal impacts due to submarining of the lap belt. It also affects seated posture to reduce fatigue and improve vibration protection.

Current Army vehicles lack knee bolsters or lower limb protection. Protruding handles, blower motors and mechanisms are in positions which can cause significant lower limb injury during frontal, as well as off-axis collisions.

Steering wheels lack energy-management design and present a serious head and chest injury hazard.

Poor head restraint in the front seating positions and no rear window to provide even minimal head and neck restraint during rear impact.

PHASE I: Identify mechanisms of injury, generate performance requirements for new crash protection systems, and identify test methods for evaluating alternative designs.

PHASE II: Identify existing, conceptual, and/or developmental systems for incorporation into Army ground vehicles, conduct trade study to identify optimum candidates and develop and integrate prototype systems into identified vehicles.

PHASE III DUAL USE APPLICATIONS: The developed designs will provide innovative technology that can be incorporated into public and private vehicles and provide occupants with increased protection and injury reduction.

A97-086 TITLE: Transmissive Sacrificial Element For Eye Protection From Lasers

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: To develop a material which will pass low energy light but blocks high energy light. Either sacrificial or self-healing concepts will be considered.

DESCRIPTION: The U.S. Armed Forces consider the protection of the eyes of military personnel against laser radiation to be a priority objective. The human eye is most susceptible to laser radiation in the range of wavelengths from 400 to 1400 nanometers and must be protected throughout this region. The non-visible portion of this spectral range can be denied access to the eye by fixed attenuation. Transmittance in the region from 400 to 700 nanometers must be preserved to maintain vision under all conditions and illumination levels. The effort sought under this solicitation is for new technological approaches to protect the eyes of combat vehicle crews from possible multi-wavelength Q-switched pulsed laser devices. The American National Standards Institute standard Z-136.1 outlines the level of laser energy versus pulse length and wavelength which can be safely allowed into the eye. The element must work in transmission and must have a low energy transmission of at least 50% (Sacrificial mirror elements are not allowed). The element can work by placement within the focal plane of a lens or in collimated space (that is not to say that it must work in both situations).

PHASE I: The contractor shall investigate and provide a proof-of- principle demonstration of an element which shows a high probability of meeting the goals as set forth in the description above. A final report shall be delivered.

PHASE II: The contractor shall fabricate, test, demonstrate, and deliver a minimum of ten elements that meet the goals set forth above. A final report shall be delivered.

PHASE III DUAL USE APPLICATIONS: Laser protection has enormous commercial applications for safety and health equipment due to the proliferation of lasers in laboratories, academia, industry and medicine. Examples include protection for industrial machining activities, medical procedures, fiber optic and free-space communications, and computing.

A97-087 TITLE: Compression Ignition Engine Combustion Improvement

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Research feasibility of and develop technologies related to improving compression ignition combustion cold start efficiency and control to enhance engine performance, while promoting use of alternative fuels.

DESCRIPTION: Low fuel temperature and cool combustion cylinder surfaces promote condensation and limit the degree of diesel fuel atomization during cold start. Glow plugs and warmers can preheat the cylinder area, but at the cost of electrical energy from the vehicle battery system, which also suffers in performance when in extreme cold environments. National strategic objectives, however, include promoting technologies that will enable the use of alternative fuels, such as methanol. These alternative fuels further exasperate the cold start problem due to lower energy densities. The Army must develop advanced engine technologies that both promote national strategic objectives and improve compression ignition engine cold start performance.

PHASE I: The contractor shall research technologies and prove feasibility of proposed concepts. Designs shall be prepared, presented and substantiated through analytical calculations and/or laboratory demonstration. Drawings for modification of an agreed to dual military- and commercial- use engine shall be submitted as an addendum to the Phase II proposal.

PHASE II: The contractor shall modify one engine to incorporate the cold start combustion enhancing technologies and perform environmental chamber performance and endurance testing to demonstrate system capabilities.

PHASE III DUAL USE APPLICATIONS: Commercial bus and truck fleets have aggressively pursued alternative fuel usage research and would readily adopt successfully demonstrated technologies that improved cold start performance and control for multiple fuel types. An Army proactive program would promote commercial engine material adoption by lowering technology insertion risks, providing increased fleet usage data, and defining material requirements and manufacturing procedures/competencies.

A97-088 TITLE: Compression Ignition Engine Technology Insertion

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Perform research feasibility of and demonstrate potential for advanced technologies, suitable for insertion in compression ignition engines to improve engine performance and assure greater conformity with future system's technologies.

DESCRIPTION: Although optimal applications of new advanced engine technologies often require alternative systems' configurations, failure to apply these new technologies to existing equipment may create future logistics and cost burdens (i.e., dual fuel delivery systems for current and future engines, incompatibilities in lubrication or electrical control systems, etc.). Much of the existing military fleet will be maintained in inventory beyond the year 2010 due to budgetary constraints on new systems developments and acquisitions. In contrast, rapid global technology advancements and foreign military R&D investments/hardware acquisitions heighten military needs and threaten U.S. superiority on the future battlefield. Army R&D initiatives, therefore, must investigate new advanced technologies' application potential for improving functional performance of existing equipment during retrograde, while retaining engine systems configurations compatibility (i.e., technology insertion through form and subsystem/component interface).

PHASE I: The contractor, having specified specific advanced compression ignition engine technologies in the proposal, shall identify and demonstrate benefits, such as product life extension, reduced maintenance, increased fuel economy, lower oil consumption and improved performance, that could be realized through an engine technology insertion program for specified combined military- & commercial- use engines. A technology insertion research/development design plan and cost savings analysis shall be prepared to document expected benefits such as improved mobility, lower level observability, greater survivability, in addition to future systems compatability. The contractor shall develop preliminary engineering designs for one agreed upon engine and specify prototype manufacturing processes required to modify an existing engine type.

PHASE II: Actual engine modification (e.g., technology insertion) shall be performed in cooperation with the Army overhaul agent (e.g., contractor or depot), manufacturing procedures verified and engine performance tests performed.

PHASE III DUAL USE APPLICATIONS: Commercial bus and truck fleets accumulate significantly greater mileage and undergo more frequent engine rebuild cycles than military ground vehicle power plants. An Army proactive program would promote commercial engine material adoption by lowering technology insertion risks, providing increased fleet usage data, and defining re-manufacturing procedures/competencies.

A97-089 TITLE: Acousto-Ultrasonic Defect Detection in Composite Armor Material

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: The objective of this program should be to develop a new technique for inspection of advanced armor composites.

DESCRIPTION: This work should aim at developing a new technique for inspection of advanced armor composites to determine structural integrity. In order to be effective, this technique must be capable of detecting defects in thick-section laminates with access limited to one side. Because lightweight armor material is relatively thick and composed of a complex combination of different nonmetallic materials, conventional nondestructive inspection techniques are unsuitable. Although ultrasonic testing can be used to detect defects in composites with fairly good accuracy, the advanced composite armor materials may use layers of ceramic materials, rubber layer, etc. and are highly attenuative and does not permit the use of high-frequency acoustic waves conventionally used in conventional ultrasonic pulse- echo testing. This study should investigate the use of advanced acousto-ultrasonic methods to meet the inspection requirements of advanced armor composites.

PHASE I: Demonstrate feasibility of using acousto-ultrasonic methods to detect the delaminations in advanced armor composites.

PHASE II: Develop instrumentation, software, and transducers to conduct A-scan, B-scan, and C-scan to detect delaminations in advanced composites using the pulse-echo technique. Demonstrate its use on an advanced armor composites at TARDEC. Deliver a portable acousto-ultrasonic system for delamination detection in advanced armor composites.

PHASE III DUAL USE APPLICATIONS: Army and automotive industry requirements to reduce vehicle structural weight and increase vehicle performance necessitates the use of advanced lightweight composite materials and advanced armor materials in the future Army Ground Vehicles and the future commercial automobiles. The advanced acousto- ultrasonic inspection technique proposed here will be useful for quality control of future army and auto industry vehicles.

A97-090 TITLE: On-Board Water Recovery Unit

KEY TECHNOLOGY AREA: Clothing, Textiles and Food

OBJECTIVE: Develop a portable system to recover potable water from vehicle exhaust or from the atmosphere.

DESCRIPTION: This project will develop the system described above to provide an alternative potable water source to small Army units or Special Operations Forces when cutoff from resupply or during extended missions. The system will be mounted on military vehicles, such as tanks or High Mobility Multipurpose Wheeled Vehicles (HMMWVs), or electric power generators and will provide drinking water to sustain several soldiers until they can be resupplied with water. The system should produce approximately 15 gallons of potable water per day be small, rugged and lightweight and shall not decrease the performance of the equipment on which it is mounted by more than 5%. Also the system, if mounted on a vehicle, shall fit inside the vehicle or engine compartment and must not extend beyond the outer frame of the vehicle.

PHASE I: The Phase I effort should a survey of published technical literature that supports the use of the proposed system on water-containing exhaust gases or atmospheric gases, design and construction of a bench-scale system to demonstrate feasibility. The technical report should include the performance specifications and the anticipated cost of a full scale system sized to be mounted on a HMMWV. The report should also address the potential operational and maintenance costs of a full-scale system.

PHASE II: Perform detailed parametric testing of the bench-scale model developed in Phase I. Use the results to develop a full- scale proto-type for Contractor/Government evaluation.

PHASE III DUAL USE APPLICATIONS: The unit may have commercial application in the survival equipment market and could be mounted on commercial recreational vehicles to provide drinking water in cases of emergency.

U.S. Army Test and Evaluation Command (TECOM)

A97-091 TITLE: Applications of Artificial Intelligence to Radar Signal Processing

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Adapt the latest techniques of artificial intelligence to create a computerized expert system to facilitate the processing of coherent instrumentation radar data.

DESCRIPTION: The U.S. Army White Sands Missile Range (WSMR) has developed measurement and data processing techniques for extracting more and better information from coherent radar signals. Target Motion Resolution (TMR) has been applied to the measurements of (1) trajectory parameters, (2) motion about the center of mass (e.g., spin and coning), and (3) characteristics of events (e.g., description, time of occurrence, and duration). Currently, a new methodology for accurately obtaining images from wideband coherent radar data known as Complex-Image Analysis (CIA) is being adapted to the problems of measuring (1) attitude of missile and aircraft, (2) miss distance between interceptors and targets, (3) detection of deployed objects, and (4) extent of damage to targets, all at high altitudes or long ranges. These developments are greatly increasing the capability of the instrumentation radars at WSMR.

Unfortunately, they are also increasing the complexity of data reduction processes and the workload of the analyst. As a result, it is becoming essential that both the radar signal processing expertise and the processing procedures be built into the workstation -- as much as is practical. The overall goals are to increase the speed, efficiency, and accuracy of the data reduction process and to decrease manpower requirements.

PHASE I: Determine which processes are suitable for inclusion in the expert system and how the system should be configured and operated. This will require a thorough examination of what the current processes consist of, how they operate, and how they can be improved.

PHASE II: Develop a prototype radar data processing workstation which incorporates the expert system and the TMR and CIA processing software. Develop the necessary processing procedures and instructional materials for the data analysts to use. Demonstrate all significant aspects of the system.

PHASE III DUAL USE APPLICATIONS: Current radar data processing workstations developed under SBIR are now being commercially marketed. The inclusion of an expert system will greatly enhance its marketability.

A97-092 TITLE: Correction of Imagery Distortions Due to Optical Turbulence at Low Angles of Incidence

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a capability to correct images based on fiducials which can be placed in the field-of-view near an imaged object.

DESCRIPTION: Imagery is used to measure characteristics of imaged objects. These characteristics include: position in space, attitude, shape, etc. Distortions due to varying atmospheric refraction restrict the ability to accurately make these measurements. A common requirement is imaging a stationary object, such as target scoring or imaging an object passing through the field of view. A wider application is the imaging of objects which are being tracked while moving.

A minimum requirement is the ability to correct images based on fiducials which can be placed in the field-of-view near the imaged object. Highly desired requirements would be the ability to do correction on natural scenes without/with minimal fiducials. A system concept that would work with moving scenes (tracking cameras) would be highly desirable.

It is desired that the concept be capable of correction at Video frame rates (60hz) with the development of appropriate hardware and software.

PHASE I: Demonstration of system concept using mathematics to emulate the process on a set of real distorted images.

PHASE II: Development of a working system with the capability of real-time (60 images/sec) or sampled depending upon computational power required.

PHASE III DUAL USE APPLICATIONS: A wide variety of applications where imagery of natural scenes over long distances is required, e.g. film, television & surveillance.

A97-093 TITLE: Dynamic Built-In Test/Simulation (DBITS) Using Synthetic In-Band Visible/IR Scene

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop an innovative solution to provide dynamic built-in test/simulation (DBITS) capability for projecting dynamic infrared and visible scenes into the entrance aperture of tactical FLIR & TV target acquisition sensors.

DESCRIPTION: The Army is seeking innovative solutions to provide dynamic built-in test/simulation (DBITS) capability for projecting dynamic infrared and visible scenes into the entrance aperture of tactical FLIR & TV target acquisition sensors. Currently, the built- in test capability for the Army's second generation FLIR and TV target acquisition sensors is limited to static targets/scenes which are projected through built-in collimators. With the recent progression of laboratory-grade infrared scene projectors, the reality of scaling this technology to fit onboard a target acquisition sensor is realizable. Visible projection systems are also realizable with the advent of high resolution flat panel displays. This type of BITS capability would provide the tactical systems with an innovative, arbitrarily reprogrammable, on-board test/simulation tool for evaluating EO sensor performance at a much higher level - to support the modern forces of FORCE 21.

PHASE I: Develop a concept and requirements for a built-in IR and visible scene projection system for built-in-test/simulation capability on the M1 Abrams or M2/M3 Bradley target acquisition subsystems.

PHASE II: Design and fabricate a proof-of-concept (POC) version that would also be integrated onto an actual tactical system for demonstration

PHASE III DUAL USE APPLICATIONS: Potential markets include training simulations, virtual reality engines, and other image intensive simulation applications.

A97-094 TITLE: High Output, Near-Monodispersed Bioaerosol Generator

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: To produce a bioaerosol generator that can produce a near- monodispersed (not the typical log normal size distribution observed for most atomizers) aerosol between 3.0 - 10.0 micrometers. The output must be between 5000 - 1,000,000 particles per liter of test air. This aerosol generator will be used in laboratory test chambers.

DESCRIPTION: The system should be both computer and manually controllable. Biological simulants to be generated include Bacillus subtilis (spore simulant), Erwinia herbicola (vegetative simulant), and ovalbumin (high molecular weight protein toxin simulant). The bacterial simulant are typically placed in distilled water at concentrations around 1x10E10 CFU/ML. Currently we are using a computer printer cartridge to produce very nice, near monodispersed aerosol from 4.0-8.0 micrometers, but the output is too low to adequately challenge some biological detection systems.

PHASE I: Produce concept model and prove that a near monodispersed bioaerosol can be generated within the appropriate particle size limitations.

PHASE II: Produce a computer- and manually-controllable bioaerosol generator.

PHASE III DUAL USE APPLICATIONS: A bioaerosol generator such as the above outlined instrument has application in the agricultural industry, particularly in the dispersion of pesticides.

A97-095 TITLE: Six Degree-of-Freedom (DOF) Motion Simulation and Vibration Platform

KEY TECHNOLOGY AREA: Battlespace Environments

OBJECTIVE: Develop and demonstrate a six DOF simulation and vibration platform that can provide up to plus or minus 8 degrees of motion using existing equipment; design and develop a platform that can provide up to plus or minus 30 degrees of motion; and configure the platform such that live missiles, rockets, or projectiles may be fired into a land based test range.

DESCRIPTION: Electrohydraulic vibration systems have been developed to perform transportation vibration tests on vehicles, shelters, and large missiles. The commercial sector has developed hydraulic systems which simulate road surface vibration environments imparted to the four wheels of a vehicle. This technology uses low frequency (0-25 Hz), long stroke hydraulic actuators. These low-frequency systems can also be employed to create sea-borne craft motion. Shipboard motion simulators can be designed and fabricated to test missile guidance systems under rough sea conditions. Live missiles can be launched from motion platforms from land based test ranges.

PHASE I: A six DOF motion platform will be assembled utilizing existing electrohydraulic vibration equipment. Performance tests will be conducted to measure system operating parameters and reliability. In a concurrent effort, a study will be performed resulting in a new platform design capable of plus or minus 30 degrees of angular displacement and 60,000 lbs capacity. The new design will focus on (1) portability of the motion platform so that interrange operability is possible and (2) reconfiguring the current system to obtain the required performance parameters.

PHASE II: Components will be procured and assembled into the new motion platform design and again be performance tested. The new motion platform shall be hardened and configured for the firing of live missiles, rockets, or projectiles.

PHASE III DUAL USE APPLICATIONS: The ability to provide controlled motion in six axes is useful in testing of full up systems. This test capability could detect problems that occur in service and are not detected in component testing. The vibration motion of the platform can be controlled to provide a more realistic structural fatigue life simulation. Potential test items include wheeled vehicles, tracked vehicles, space bound payload sections, missiles, rockets, launch systems, and equipment used in nuclear power plants that must endure seismic events.

A97-096 TITLE: Digital Video Workstation

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop and demonstrate a system capable of recording multiple (at least four) video sources simultaneously in digital format. Video format shall be conformed to accepted industry standard and allow full size live video play back (30 frames per second). The system must also include hardware, firmware, and software to retrieve, play back, and process the stored video signals recorded from each source.

DESCRIPTION: In order to determine performances of a gun system (large caliber), impacts on multiple targets, that are placed in a flight path of a projectile, are investigated. The time of flight of the projectile lasts about three seconds. A digital video camera is placed at each target location to record the impact of the projectile on the target. Recorded video is then played back to determine the projectile impact location on each target. Current commercially available instruments such as a computer with a special video board cannot record multiple video sources simultaneously. Digital Video Tape recorders can be combined to satisfy the requirements but may include many unnecessary editing functions with high cost. Innovative ideas, and design concepts are needed to develop an efficient system that integrates new technology in video, electronic, and image processing to allow recording, storing multiple video signal sources, and processing the stored signals.

PHASE I: Investigate, present, and demonstrate an innovative concept and design of an instrument that is capable of simultaneously recording and storing signals from multiple digital video sources separately and video format must meet accepted industry standard; full size play back, matching the resolution capability of professional digital cameras at live video frame rate (30 frames per second or better); accurately fast-searching, displaying, and storing single frame for use with image processing software; and operate from a single workstation.

PHASE II: Implement the design and field the system. Included firmware and software in form of objects, and library functions to allow flexibility in further development of software for use in multitasking environment using C, C++ compilers.

U.S. Army Research Institute (ARI)

A97-097 TITLE: Improved Soldier Decision-Making in Urban Settings

KEY TECHNOLOGY AREA: Manpower, Personnel and Training

OBJECTIVE: To identify critical facets of soldier decision-making for operations in urban settings and to develop prototype training techniques to enhance decision-making and performance in such environments.

DESCRIPTION: The U.S. Army can expect to conduct operations in urban settings more frequently than in the past. Effective performance in urban settings hinges on the application of strong, highly relevant decision-making skills. Urban zones vary considerably as to their nature and the personnel located therein may be hostile, friendly, or neutral. Soldier decisions in urban settings must consider the nature of the urban setting (type of building construction and framing, floor plans, and residential building characteristics) and the variety of personnel likely to be encountered. Performance measurement of effective decision-making will include lethality or the application of force resulting in enemy casualties, survivability or the preservation of friendly forces and non-combatants, and timeliness or rapid performance in an urban environment. Without adequate training, soldiers or law enforcement personnel, for example, who have successfully encountered and engaged targets in a series of room clearing operations may have a tendency to enter the next room and incorrectly engage innocent civilians. Appropriate decision-making in urban settings under specific circumstances will result in favorable outcomes as measured by lethality, survivability, and timeliness. Behavioral observation of soldier performance during training exercises where the urban conditions are systematically varied and the outcomes measured could identify one approach to soldier decision- making and performance which is highly effective. Once identified and included in the training design, soldier decision-making in urban settings would be substantially improved. Law enforcement and other civilian emergency services might make use of the same, or similar, decision-making training. The contractor will develop a conceptual model of soldier decision-making in urban settings identifying critical decisions, varying urban circumstances, and appropriate metrics. The contractor will then observe soldier decision-making performance during urban training exercises and develop prototype training techniques for the critical soldier decisions identified.

PHASE I: This phase includes the development of a conceptual model of soldier decision-making in urban settings. This will include the development of a taxonomy for specifying and organizing the varying conditions relevant to decision-making in urban settings. Also included will be the development of prototype performance measures to assess decision-making.

PHASE II: This phase will include the development of prototype training techniques and prototype training materials for critical decision-making in the urban settings identified.

PHASE III DUAL USE APPLICATIONS: This phase includes tailoring the prototype decision-making training approaches to other military and commercial markets. There is a potential commercial market for training which is effective for rapid decision-making in high risk urban situations such as police actions, emergency medical treatment, and fire fighting.

A97-098 TITLE: Computer-Based Human Gesture Recognition for Command and Control

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: To develop an integrated system for recognizing natural human hand gestures and facial expressions to control and communicate with automated entities.

DESCRIPTION: Many activities require humans to communicate via hand gestures, and human emotional interaction is replete with communicative facial expressions. Examples are: combat leaders signaling unit formations, movement and combat actions; communicating face-to-face commands; ground personnel controlling aircraft landing and taxiing operations; and construction workers directing crane operators. Automated recognition of hand gestures and facial expressions would be very helpful in training and as a means of remote vehicle control. Existing Graphical User Interfaces (GUIs) incorporate human hand gestures in only two dimensions (through artificial devices such as a mouse or joystick) or more recently in three dimensions with gloves that record hand positions dynamically. In addition, pattern recognition systems could be used to recognize hand gestures visually. The potential for augmenting menu- or natural language-based computer communication systems with gestural signal processing for computer-aided design, simulation, or training merits extensive exploration within an application area.

PHASE I: The first phase of work should demonstrate the utility of hand gesture-based control and communication in an application area such as training mission rehearsal, or command and control. The algorithms for dynamic gesture recognition should be stabilized and they should be demonstrably scaleable to larger numbers of gestures with linear increases in processing power. A principled theory should be developed to guide the cognitive engineering of acceptable gestures that are easy to learn and map directly onto tasks. A working prototype of the system using off- the-shelf hardware should be completed. The superiority of gesture-based control over other interfaces will be demonstrated in selected application areas. Guidelines for integrating gestures with existing menu and key control systems will be developed. The system should be capable of tracking

human body positions accurately with relatively little intrusiveness and susceptibility to environmental interference's (such as electromagnetic fields); classifying both static and dynamic body, hand, face, and expressive positions as gestures; and communicating the resultant commands to real or simulated entities (such as remote vehicles, computer entities, or other individuals).

PHASE II: A large-scale hand gesture, body position, and facial expression recognition package will be developed to interface to a commercial software product that takes full advantage of these gestures power for easy communication and control.

PHASE III DUAL USE APPLICATIONS: This phase entails executing and validating the utility of the hand gesture recognition system in a military or civilian setting. Commercial applications in many areas of software interfaces will take advantage of these findings. Gesture - based interfaces could provide entertainment system developers with a powerful new capabilities to greatly enrich the experiences provided to users. If a gesture - based interface can be developed, and if it is applicable to a broad range of devices, it might be used for training in situations of mission rehearsal that require silent gestures. If it can utilize existing sensors it should be widely marketable in many other application areas.

A97-099 TITLE: Dialogue-Based Language Training

KEY TECHNOLOGY AREA: Manpower, Personnel and Training

OBJECTIVE: To develop an authorable tutor that teaches by engaging trainees in dialogue in a generated graphics environment. The animated dialogue partner will be displayed through the use of generated graphics. The dialogue partner will be capable of producing spoken language or typed output. The tutor will be capable of accepting either typed or spoken input. The resulting tutor will be capable of teaching military information and procedures.

DESCRIPTION: Current and future joint and international activities demand improved access to foreign languages which can be provided on demand in either standalone or distributed, internetted environments. This research will produce a dialogue-based tutor that is fully authorable by non-programmers. More than one approach to this development will be considered. That is, a natural language processing (NLP) approach will be considered, but is not required. Whatever the approach, the resulting system must be capable of dealing with complex constructions, such as anaphora, and must have a significant language generation capability. The system must allow instructors to add new words, particularly nouns, to the finished product so as to customize lessons. Such additions will not require that the instructors be either computer programmers or computational linguists. The tutor system must permit the creation of a wide variety of new dialogue-based lessons. Any system that permits the creation of new lessons (whether a knowledge base or other approach) also must be authorable by non-programmers. The initial dialogue system will be developed in English, and will be capable of supporting a wide variety of military informational and procedural lessons.

Trainee input to the dialogue will be by keyboard and by voice. System output will be by text and by speech. When speech output is the selected mode, the system will generate an animated dialogue partner which is capable of producing realistic facial movements which synchronize with the speech. Since the speech output will be unpredictable, the animation will have to be generated. The desired platform for this tutor system is an advanced PC running Windows95 or its successor, or Windows NT or its successor. It is desired that all graphics generation be handled via software; however, if this proves impractical, hardware/firmware solutions will be entertained. To the extent possible, existing software is to be utilized.

This military information and procedures dialogue tutor will integrate all the advanced features described above, will be both standalone and distributed, and will be internetworked in its delivery. The development of a military dialogue-based lesson will provide a demonstration of the authoring capability and thus demonstrate an intrinsically useful product for the Army.

PHASE I: In Phase I the contractor will develop the conceptual approach and the detailed design of the system incorporating the elements described above. This will include all the required interface screen designs, including required authorability. The military dialogue-based lesson and its internetted delivery will be defined and outlined.

PHASE II: In Phase II the contractor will develop the software described above and integrate it with existing software as required. The contractor will alpha and beta test the resulting software and make required fixes. The contractor will develop and integrate a new military tutor lesson. This scenario will fully demonstrate all functional aspects of the tutor system, including authoring, speech input and output, and animated graphics output.

PHASE III DUAL USE APPLICATIONS: The potential commercial market for a language tutor that can engage students in realistic dialogue such that the dialogue can be altered by instructors, is significant. It is this dialogue capability that defines the real task of language use. As such, being able to practice dialogue capability is central to learning a new language. To the extent that such an authorable dialogue component can be added to existing Army language tutors, it will greatly enhance their training value and cost-effectiveness. The ability to simulate an instructor in a one-on-one dialogue has always been the primary goal of computer-based language learning. It is this type of teaching that has always been the most effective, but also the most costly. Current advances in natural language processing now make simulating dialogue possible. The potential commercial market for a

tutor that can teach through dialogue is very large. When the dialogue of such a tutor is authorable, and the delivery internet-worked, the potential market expands to an even greater extent. The conversion of the military knowledge and procedures tutor to a general or industrial tutor would be relatively easy and also of great commercial value.

U.S. Army Construction Engineering Research Laboratory (CERL)

A97-100 TITLE: Cyanobacterial Inoculants for Arid Land Reclamation

KEY TECHNOLOGY AREA: Environmental Quality/Civil Engineering

OBJECTIVE: To develop an economical methodology to apply viable cyanobacterial cultures to disturbed arid soils. Given the lack of water in arid regions, the methodology should not rely on hydro-applications.

DESCRIPTION: The stability of many semiarid and arid soils is dependent, at least in part, on the presence of well-established biological soil crusts. The crusts are formed by microbial filaments and mucilaginous exudates of various surface-dwelling microphytes, particularly cyanobacteria (bluegreen alga) that bind soil particles into a stable, aggregated surface. With increasing aridity and the concomitant decline in the abundance of vascular plants, the stabilizing role of biological soil crusts becomes increasingly important. Well-established crusts are resistant to the erosive forces of both wind and water. When biological soil crusts are destroyed, wind and water erosion can accelerate manifold. Natural recovery of biological soil crusts can span decades. Given the inherent low rainfall rates in semiarid and arid regions, restoration of these ecosystems has often been considered impossible. Recent developments, however, illustrate that soil stabilization and accelerated restoration can be accomplished through the application of native cyanobacteria to the soil surface.

PHASE I: Develop methodology to apply live cyanobacterial inoculants to the surface of disturbed arid soils. The methodology may involve encapsulation, pelletization, coating of seeds or inert carriers, powder, or any other method that meets the following criteria: (1) The methodology must use live, naturally-occurring, filamentous, terrestrial cyanobacteria such as microcoleus vaginatus; (2) The inoculant must have a viable shelf life of a least one year; (3) Application of the inoculant must not require water; (4) While development of the inoculant may require specialized equipment, the field application process should use standard rangeland drill or broadcasting equipment.

PHASE II: Develop an economically feasible prototype of a commercial-scale process for production of large quantities of shelf-stable cyanobacterial inoculant.

PHASE III DUAL USE APPLICATIONS: This technology represents the only reasonable approach to cost-effective, large-scale reclamation of arid areas. As such, there should be a significant market among Federal and State agencies involved in reclamation of disturbed lands in arid regions of the country, e.g., the DoD, Bureau of Land Management, U.S. Forest Service

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)

A97-101 TITLE: Physics-based, Dynamic, Multi-spectral, Multi-spatial Texture Generator for Synthetic Scenes for Cold Environments

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: Develop algorithm(s) and the software required to provide a high fidelity physics-based, dynamic, multi-spectral, multi-spatial texture generating (clutter) capability that can be used in synthetic scene generation, including synthetic scenes for cold environments, to portray sub-pixel resolution physical processes. This effort supports virtual proving grounds and hardware-in-the-loop visible, IR, and MMW sensor simulations of natural backgrounds.

DESCRIPTION: The recent emphasis within DoD on Modeling and Simulation, and Distributive Interactive Simulations is driven, in part, by the reduction in resources available for training of personnel and testing of new sensor systems. Recently, emphasis has been focused on the development of high fidelity, real-time simulation capabilities for training and sensor system development and evaluation. To achieve the desired fidelity it is necessary to use physics-based models at the scale the physical processes affect the energy budgets. Cold poses a unique problem because of the spatial and temporal dynamics associated with cold environments, especially in the millimeter wavelength region of the spectrum. For example, snow characteristics can exhibit large spatial, spectral, and temporal variations. This requirement to model dynamic environments makes it basically impossible to achieve a real-time capability. While the requirement for a high fidelity real-time scene simulation appear to be nearly impossible to satisfy, there is in fact an alternative solution. That alternative is to model scenes at scales much coarser than the scale of the physical processes, but include the sub-pixel effects of these processes by using physics-based texturing (clutter) algorithms. Present texturing algorithms are strictly mathematical formulations (fractals, gaussian distributions, trigonometric functions) which may or may not be representative of the sub-pixel physical processes. In fact, in a recent review of over 1,100 IR images, not a single case of gaussian clutter was found. A second approach is to develop clutter statistics based on real imagery. While these statistics are applicable only to a particular sensor at a particular location and time, there is no evidence that they can be used for other sensors, locations, and times. In fact, these statistics may not be applicable for the same sensor and location for a time several minutes after the valid time of the imagery. Data recently obtained with a 95 GHz system viewing a real snow-covered background at a fairly shallow angle exhibited large dB changes over spatial scales on the order of tens of centimeters and temporal scales of minutes.

The desired characteristics of the texture (clutter) model and software sought here are physics-based algorithms to provide high fidelity clutter information for natural backgrounds (snow, soil, vegetation canopies, etc.) over a user-defined spectral interval ranging from visible to millimeter wavelengths. The spatial scales of the clutter information should support the simulation of sensors with narrow fields-of-view (footprints of order of centimeters) to sensors that operate in search or wide field-of-view mode (several tens of meters to kilometers).

PHASE I: Develop physics-based, dynamic, multi-spectral algorithms for texturing natural environments, especially cold environments, over the spectral interval ranging from visible to millimeter wavelengths (MMW). Demonstrate the feasibility of using these algorithms to accurately model the sub-pixel physical processes associated with natural background for a dual band IR imaging system operating in Mid Wavelength Infrared (MWIR) and Long wavelength Infrared (LWIR) spectral regions and a millimeter wavelength system operating at 35, 60, or 95 GHz. In the MMW region it is important to provide high fidelity texturing algorithms or cold environments, especially snow-covered natural backgrounds.

PHASE II: Develop, test, and evaluate a platform-independent software package with a user-friendly interface that will provide a physics-based, dynamic, multi-spectral, multi-spatial texture (clutter) generator capability.

PHASE III DUAL USE APPLICATIONS: Can be used in industry for development and testing of new EO sensor systems in a virtual setting, thus eliminating costly, one-of-a-kind field programs that frequently result in incomplete and ineffective evaluation of new systems. Can also be used to provide high fidelity backgrounds for use in personnel/soldier training systems that include the effectiveness of weapons systems for different environmental and battlefield conditions. Could be used in commercial video games, especially games that include simulations of weapons systems operating in multiple spectral regions.

A97-102 TITLE: Rapid Measurement of Ice Density

KEY TECHNOLOGY AREA: Battlespace Environments

OBJECTIVE: Develop a system for rapid, accurate determination of the density of ice samples obtained in field situations.

DESCRIPTION: Accurate measurements of densities of samples of sea, lake, and river ice are necessary to calculate the mechanical and electrical properties of the ice. After thickness, density is the single most important property in determining strength of a floating ice cover and its electromagnetic signature. It is also a necessary parameter in determining whether military vehicles can safely cross frozen rivers or lakes, and for determining the ice loads that may be imposed on temporary structures such as floating bridges. Likewise, knowledge of the density of ice formed on objects by supercooled fog and sea spray is necessary to calculate loads caused by ice accumulations on structures such as antennas and vessels. Small errors in measured density can lead to large errors in calculated loads or properties. Two methods currently favored for measuring ice density are the mass - volume and submersion techniques. In the mass-volume method, the sample is weighed (usually on a portable electronic balance) and the volume determined with calipers. For the submersion technique, the sample is weighed in air and in a fluid of known density, and the ice density thus quickly calculated. The submersion method is accurate for bubble-free ice, but large errors occur for ice with connecting air channels. The difficulty with the mass-volume method is that surface irregularities prevent the accurate determination of volume.

A field-portable method of accurately ice density to an accuracy of 0.002 g/cm3 is required. Sea, lake, and river ice samples are normally collected by core sampling, resulting in 6 to 15 cm diameter cylinders (depending on auger diameter) which can be 2 to 25 cm in length. Sea spray or atmospheric ice samples may be in a variety of shapes or configurations, some with volumes of only a few centimeters. Some ice samples may be permeable, thus the submersion technique may not be appropriate. It is preferable, but not absolutely necessary, that the technique be non-destructive. Instrumentation and tools for making the measurements should be ruggedized and packaged such that they can be deployed by one person (making several trips if necessary). It should be assumed that AC power will often only be available from a small generator (1.5KVA) at the field site. The measurement technique should work in temperatures ranging from 0□ to -40□ C.

PHASE I: Determine the feasibility of developing instrumentation to accurately measure ice densities in the field conditions described above. Design and develop a "breadboard" system and prove the feasibility of the technique in laboratory tests.

PHASE II: Make necessary modifications to Phase I "breadboard" demonstration system, then design and fabricate a prototype system. The prototype system will be used in field tests to demonstrate its effectiveness.

PHASE III DUAL USE APPLICATIONS: Instrumentation and techniques to rapidly and accurately measure ice density would be useful to military units, government laboratories, academic researchers, and private companies who have a requirement for calculating ice loads on structures, the bearing strength of ice, or ice electromagnetic properties. Depending on the technique adopted, the same system concept also may be useful for determining the density of other natural and composite materials, which would considerably expand its commercial potential.

U.S. Army Topographic Engineering Center (TEC)

A97-103 TITLE: Global Positioning System (GPS) - Based Geospatial Data Capture System

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop a GPS-based , nongraphical database system for in-theater and commercial uses. The system will include a module compatible with the Precision Lightweight GPS Receiver (PLGR) and software to access, display, and value-add data.

DESCRIPTION: The long range goals beyond this SBIR are for National Imagery and Mapping Agency (NIMA) to send data directly to fielded units via the Global Broadcasting System (GBS) and for the soldier to have a small screen display to access these data graphically. As these capabilities are still years away, this SBIR topic seeks proposals for a solution that will satisfy database access requirements in the short term. A solution of this problem also serves as a prototype which will determine feasibility of the long range goals. The proposed solution may involve the utilization of existing capabilities to facilitate ease of implementation. The primary task is the developent o fa PLGR module to include a hard disk for data storage and access. Vector Product Format (VPF) data applicable to the specific training or in-theater operation would be loaded directly into the PLGR module via existing serial port connections. The user would have the ability, through the use of menu options and customized software, to query, access, and display tabular feature and attribute data within the vicinity (user-defined proximity range). The database search origin would be based on current GPS coordinates (existing capability). Additionally, the user would be able to value-add features and attributes based on a Feature Attribute Coding Catalogue (FACC)-compliant data

dictionary. These updates would be communicated back to the field via serial port connection when the PLGR module is returned for a data update.

PHASE I: Establish implementation plan for the development of the following:

-- a small writeable hard-disk (200-500 MB) for the PLGR module;
-- procedures to create mission specific databases small enough to be loaded into the PLGR module;
-- a database-specific data query dictionary of applicable coverages, feature codes and attributes;
-- a database load capability;
-- software which uses GPS coordinates for database query purposes;
-- menu options to permit query and value adding functions; and
-- routines to upload value-added data to the field unit MSIP.

PHASE II: Monitor hardware and software development. Assess database access speed, reliability, positional accuracy, suitability for Army and civil use, ease of functionality and adherence to VPF and production standards. Perform data quality evaluations and post-study evaluation of concept. Make recommendations for improvements and implementation in fielded environment.

PHASE III DUAL USE APPLICATIONS: The ability to access and value-add vector database information using the nongraphical PLGR interface has far-reaching potential for both DoD and civilian uses. It would eliminate the need for every soldier or civilian data compiler to be equipped with a sophisticated Geographic Information System (GIS) capability. A logical evolution of this concept would involve direct satellite-based access of constantly updated database information and development of a graphical small-screen display. Methodologies developed through this effort can be directly integrated into other remote access and database-update applications. This concept provides a cost-effective and simple way to receive up-to-date information significant hardware re-engineering while freeing the individual from the burden of a graphical display. It can also be utilized, after the deployment of a small-screen display, by users who do not have a visual display.

U.S. Army Waterways Experiment Station

A97-104 TITLE: Enhanced Buried Unexploded Ordnance Detection and Discrimination Technology

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of novel sensing technologies for enhanced detection and discrimination of buried unexploded ordnance (UXO).

DESCRIPTION: There exists a critical need for sensors capable of detecting and discriminating buried unexploded ordnance in the presence of natural and man-made clutter. The results of the demonstrations of UXO sensing technologies conducted at the Jefferson Proving Ground, IN (JPG) have shown that there are no off-the-shelf technologies that can perform the UXO detection mission with adequate probability of detection at acceptable false alarm rates. The Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) have made investments in sensor development and demonstration, respectively. The purpose of this SBIR project is to investigate on novel sensing and data interpretation approaches that can be applied specifically to the buried UXO detection and discrimination problem. Of particular interest are novel chemical, electromagnetic, or nuclear methods that can accurately detect the presence of explosives in buried UXOs. Target explosive compounds include TNT, RDX, HMX, and PETN. The capability to remotely detect the presence of these explosives in buried munitions would significantly reduce the high false alarm rates common to the currently available UXO detection systems.

PHASE I: During the Phase I effort, contractors would explore (basic and/or applied research level) innovative sensing approaches that could be developed into a prototype sensor capable of detecting buried ordnance in a variety of environmental and geophysical conditions. Deliverables from the Phase I effort will be the design of a prototype sensor and performance estimates based on laboratory experiments and/or modeling results.

PHASE II: During Phase II, a rugged, field-capable prototype sensor system would be fabricated, tested, and delivered to the Army. The testing effort would include laboratory demonstrations followed by field tests/demonstrations at prepared and actual UXO sites to determine the performance of the prototype system in real-world UXO detection operations.

PHASE III DUAL USE APPLICATIONS: It is estimated that up to 11,000,000 acres in the United States alone may be contaminated with UXOs, primarily from past and current DoD and DOE operations. A sensor system for enhanced detection of buried UXOs would have tremendous commercial potential for firms involved in the characterization and remediation of these lands. In addition, sensors capable of detecting trace levels of explosives would have a wide range of commercial applications such as airport security, law enforcement, and humanitarian de-mining operations.

A97-105 TITLE: Multiple Simulated Bomb-Fragment Explosive Launcher

KEY TECHNOLOGY AREA: Environmental Quality/Civil Engineering

OBJECTIVE: To develop a system to explosively launch an array of scaled simulated bomb fragments at velocities representative of those produced by general-purpose (GP) and penetrating conventional weapons and in controlled and predictable patterns.

DESCRIPTION: The loading, localized damage, and structural response produced by the fragments from a conventional weapon detonating in a structure can be studied by conducting scaled experiments using various shapes of steel masses to simulate bomb fragments. Single-fragment experiments have been conducted at 1/4 scale, using gun barrels to fire steel masses at the required velocities into structural elements. Some of the structural elements were suspended as a pendulum to study the momentum transfer from the fragment to the slab. In addition to the single-fragment experiments, 1/4-scale multiple-fragment experiments have been conducted in which a block of explosive material was used to launch an array of 24 fragments into the test specimen. At present, no system is available in which various arrays of steel masses can be propelled at velocities representative of bomb-fragment velocities in a controlled and predictable pattern.

The system should be capable of propelling arrays containing between 10 and 30 steel masses at velocities ranging from 2,000 to 6,000 fps in a controlled and predictable pattern covering an area of about 500 square inches. The shapes of steel masses, which will weigh between 50 and 800 grains, should represent both chunky-type fragments and long slender fragments. The airblast loading on the test specimen should be minimized to prevent significant pendulum motion due to airblast.

The development of this launcher would support the investigation of the vulnerability of foreign structures to conventional weapons effects. These structures may include hardened command and control bunkers, and facilities used to produce or store weapons of mass destruction. The experimental data obtained using the launcher would be beneficial to the development, improvement, and validation of numerical models used to predict weapons effects on structures, and to develop future weapons and protective materials.

PHASE I: Conduct a study of available bomb-fragment data to determine the appropriate 1/4-scale simulated fragment weights and velocities for several GP and penetrating conventional weapons. The fragment weights to be considered should be the heaviest 10% of the fragments for a given weapon. Conduct a feasibility study and provide concept designs of launcher systems for testing in Phase II.

PHASE II: Develop the most promising concepts and conduct proof tests that incorporate the range of fragment shapes, weights, and velocities of interest as determined from the Phase I study. Provide a procedure for using the launcher system with any set of fragment parameters appropriate to the weapons of interest.

PHASE III DUAL USE APPLICATIONS: This developed system will have application in research and testing of common building materials, assemblies, and equipment in conventional civilian building designs where explosion effects are a design consideration. Also, information gained from the use of this system can be disseminated to civilian building-design professionals as one component of an integrated threat deterrent and blast-effects mitigation strategy.

U.S. Army Medical Research and Materiel Command (MRMC)

A97-106 TITLE: Non-Invasive, Non-Contact Physiological Sensor for Determining Heart Rate, Cardiac Output, Electrocardiogram, Breathing Rate, & Environmental Threats

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: To measure the physiologic variables, as listed in the title, by non-invasive, non-contact means. Non-contact is described as a distance from the body greater than 1 cm. To detect imminent physiological threats in the ambient environment.

DESCRIPTION: Rapid determination of vital signs at scenes of trauma, including combat trauma, is crucial to rapid triage and assignment of appropriate treatment personnel (first responders) in a pre-hospital setting. The U.S. Army wants to develop sensors which can quickly scan for vital signs. Such sensors may operate in acoustic, bioimpedance, bioelectric, microwave, thermal sensing, or other modes, but must, in their final form, be small (e.g., the size of a quarter dollar), lightweight, portable, supportable by small, hand-held, PC-based computers, and integrated into a single sensor suite. To be useful in the Warfighter Physiological Status Monitor, smart sensors must not only detect stimuli but also automatically process the data into meaningful information and relay such through a local area network embedded in the soldier's uniform. The information must then be transmissible to command and medical personnel who will have specialized receivers. Such a system will be useful not only for military but for many civilian applications, allowing health and safety monitoring of, for example, firemen, police, and rescue workers in action as well as medical patients. In the latter case the system could allow, for the first time, a wide spectrum of monitoring capabilities for patients outside of a restrictive hospital setting.

PHASE I: Phase I will develop the concept, show feasibility, and produce proof-of-principle, breadboard prototype. Demonstration of performance and report are required.

PHASE II: Phase II will develop working prototype of physiological sensors, with PC-based interface, and must be demonstrated in a laboratory environment. A report will also be required.

PHASE III DUAL USE APPLICATIONS: Demonstrate the reliability and validity of the previously developed bioelectronic hazard sensors to detect, evaluate, and accurately report external environmental and internal physiological threats to health and life of soldier operating in realistic field environment.

A97-107 TITLE: System for Improved Plasma or Platelet Storage

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Improve the Availability of Platelets or Plasma for Emergency Use

DESCRIPTION: Current blood bank technology allows the storage of frozen human plasma for up to one year. In recent experience with frozen plasma in the field, 80% of the thawed bags are unacceptable for transfusion due to storage bag breakage. Purified or partially purified plasma proteins have been successfully dried and freeze-dried. Technology to apply these processes to whole plasma is available.

Current blood bank technology allows the storage of human platelets at 22-24□C for up to 5 days. The major limitation of platelet storage is bacterial contamination. Present platelet cryopreservation methods are unacceptable because of the laborious post thaw processing and toxicity of the agents. Alternate storage methods of platelets and plasma would allow increased availability in remote locations but must not compromise quality, safety, or ease of use. The understanding of membrane permeability to cryoprotective agents and protein solution tolerance to drying/freeze-drying is a minimal requirement for developing a successful platelet or plasma storage product.

PHASE I: Identify the fundamental biophysical principles critical for whole plasma drying/freeze-drying or cryobiological principles critical for platelet cryopreservation. Identify biophysical and biochemical parameters to be controlled in product processing. Identify preservative agents acceptable for human use. Define storage and reconstitution solutions not requiring post storage processing. Demonstrate that the product provides a functional plasma protein or platelet recovery of 80% or better.

PHASE II: Define a large scale drying/freeze-drying process for plasma or cooling/freezing/freeze-drying for platelets. Demonstrate longevity of plasma or platelet products through long term storage studies. Perform or participate in clinical testing of the defined product to include conventional in vitro testing followed by in vivo testing for recovery and survival studies.

PHASE III DUAL USE APPLICATIONS: Produce and support a plasma or platelet storage product during its introduction into clinical use.

A97-108 TITLE: Mode of Action of Insect/Arthropod Repellents

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Study mode of action of insect repellents, determine physical, chemical and biological factors that contribute to arthropod repellency.

DESCRIPTION: Conduct basic studies of the responses of the olfactory and contact chemoreceptors of insect repellents in common use. The detection of chemicals by insects involves changes in the electrical activity of chemoreceptor neurons in sensillae located on the antennae, tarsi, and other body parts. These changes are thought to arise as a consequence of interactions between chemical molecules and protein molecules located on the dendritic surface of the receptor neuron, which result in alteration of the rate of generation of the action potential. The response characteristics of the receptors are assumed to be adaptively related to the insect behavior in nature. Knowledge of the mode of action of repellents on chemoreceptors and the dose required to generate the threshold-level response can be applied to develop specific repellents which can be combined as new, effective and longer lasting repellent formulations.

PHASE I: Determine mode of action of insect repellents.

PHASE II: Demonstrate usability of methodology to formulate insect repellent formulations.

PHASE III DUAL USE APPLICATIONS: Conduct field efficiency studies of insect repellent formulations Several military relevant arthropod vectors transmit infectious diseases, posing significant public health hazards throughout the world. Because of growing resistance of vectors to insecticides and the effect of chemical control measures on the environment has posed several restrictions. Study of mode of action leading to development of effective insect repellents for personal protection would be a significant advancement in prevention of transmission of infectious diseases.

A97-109 TITLE: Malaria Genome Research-Screening the Genome for Antimalarial Targets

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Malaria is an important casualty producing disease that has impeded U.S. military operations throughout our history. Although there are several available drugs to prevent and treat malaria, the global emergence of drug resistant strains threatens the effectiveness of these drugs. Without continued discovery of new drugs, U.S. troops will be left vulnerable to substantial levels of noncombat casualties resulting from infection with malaria. The best strategy for developing new antimalarial drugs is through a rational protein structure-based design whereby target proteins serve as templates for the design of inhibitory compounds.

DESCRIPTION: Potential antimalarial drug targets may be identified among ligands which bind tightly to functional sites on regulatory enzymes and other proteins that are essential for parasite survival. Identifying these targets requires the discovery of novel genes that code for these important proteins. New technologies now make it possible to efficiently screen the genome by cloning and sequencing only small portions of each gene. This results in a gene sequence tag or an expressed sequence tag (GST, EST). Large numbers of GSTs can be quickly compared to the huge database of known gene sequences to identify those which may be genes of interest. Gene sequence tags associated with identified clones in a representative set of clone genes provide key information needed to identify, continue sequence analysis, and map a significant proportion of the genes of the parasite. This process greatly accelerates the search for new drug targets by rapidly and inexpensively identifying large numbers of previously unknown and/or undiscovered malarial genes. Once genes of interest are identified, the process of protein expression and characterization can proceed. Since many genes and proteins can be studied simultaneously, the critical and initial rate limiting step in this drug discovery process is knowing which genes and proteins to study. Furthermore, a genome sequence database serves as the essential link required to efficiently utilize the vast amounts of potentially applicable data expertise available in other segments of the biomedical research community, which may be helpful in developing novel antimalarial drugs.

PHASE I: Produce a library of >2,500 GSTs for Plasmodium falciparum. Develop analytical computer tools that provide multiple means of evaluating the validity of gene identifications made by sequence homology, an efficient method for identifying gene function from gene sequence and a data storage and processing system that interfaces with genome databases and is in a readily searchable and upgradeable format.

PHASE II: Identify the most promising drug targets and clone the full length genes. Express the protein products of these genes, and then purify and characterize these proteins.

PHASE III DUAL USE APPLICATIONS: The commercial market potential is excellent, especially for antimalarial drugs and other anti-infectives used by international travelers. Antimalarial drugs also have applications in cancer chemotherapy and for opportunistic infections in HIV patients.

A97-110 TITLE: Systems for Improved Red Blood Cell Storage

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Improve the availability of red blood cells for emergency use by increasing the duration of their liquid storage.

DESCRIPTION: Current blood bank technology allows the storage of human red blood cells in liquid form at 1-6ºC for periods up to six weeks. Longer storage periods would allow increased blood availability in remote locations but should not compromise quality, safety, or ease of use. Since the red blood cell storage lesion appears to be in part related to oxidative damage to red blood cell membrane proteins and since oxygen does not appear to be necessary for red blood cell metabolism, systems for simple and cheap blood deoxygenation and storage should be developed and tested.

PHASE I: Design, produce, and deliver prototypes of systems for deoxygenating human packed red blood cells (pRBCs) that are fully compatible with modern closed system blood bags and blood banking techniques. Demonstrate that the systems successfully reduce oxygen partial pressure below 2 mm Hg (remove 98% of the oxygen) and can maintain oxygen concentration at or below that level.

PHASE II: Perform or participate in clinical testing of the prototype system to include conventional in vitro testing of the stored pRBCs followed by in vivo testing with autologous human RBC recovery and survival studies.

PHASE III DUAL USE APPLICATIONS: Produce and support such a pRBC storage system during its introduction into clinical use.

A97-111 TITLE: Non-Invasive Device and Method for Measuring Blood Hermatocrit

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Development of methodology and a robust, small, lightweight, easy-to-use, non-invasive device for near-continuous monitoring of blood hematocrit in the forward echelons (starting with the field medic).

DESCRIPTION: This project entails the development of a device and methodology for measuring blood hematocrit non-invasively. The final device prototype should include a sensor apparatus and unique hardware and software required for hematocrit measurement. The device should be capable of outputting either digital data through an RS232 port, or analog data through leads which may be easily connected to off-the-shelf data acquisition products (e.g., amplifiers, A/D boards) and acquired via commercially-available data acquisition software; this project is not concerned with the development of data acquisition monitoring or display devices. The sensor and any supporting hardware should utilize minimal battery power, not necessarily internal to the sensor/hardware package. The final product must be robust, small, and lightweight for far-forward use in a combat environment. The sensor must be easy to use given the training level of the primary user (the field medic) and the environment (high stress, combat conditions). The sensor should be capable of providing near-continuous monitoring of blood hematocrit (at least 3 measurements per minute) for sustained periods of time (72 hours). Hematocrits (% by volume of red blood cells) measured using this sensor must agree within 1 hematocrit point to hematocrits measured simultaneously using the standard technique (spun arterial or venous blood samples read using a micro capillary reader.)

PHASE I: The Phase I effort should demonstrate feasibility in the form of a prototype device. The phase I effort should include data demonstrating that hematocrit measurements obtained using the prototype agree with measurements made using a micro capillary reader. The prototype need not meet the requirements for robustness, weight, size, data compatibility, power mode/consumption, or ease-of-use required of the advanced prototype. However, a discussion of how these requirements would be met in the advanced prototype should be provided.

PHASE II: The Phase II effort should result in an advanced prototype meeting the robustness, weight, size, data compatibility, power mode/consumption, ease-of-use, and accuracy requirements set forth in the description. Physiological data demonstrating accuracy, robustness, and ease-of-use over a wide range of hematocrits, blood pressures, and blood flow rates, must be included in the Phase II effort.

PHASE III DUAL USE APPLICATIONS: Hematocrit is among the most common medical tests performed. The device and methodology developed as part of this research will enable hematocrits to be measured non-invasively, eliminating infectious disease risks associated with drawing and handling blood specimens, as well as allowing the test to be performed in most any environment. This research will benefit the civilian sector in providing a non-invasive alternative to the traditional blood-draw method, as well providing the means for hematocrit measurement during patient transport and at remote or austere sites. This research will benefit the military medical community for these same reasons, but primarily for the ability to measure hematocrits in a combat casualty, at or near the time of wounding, and from these measurements, to gauge blood loss and efficacy of resuscitative fluids.

A97-112 TITLE: Molecular Targeting of Botulinum Toxin to the Motor Nerve Terminal

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: To develop a targeting system for delivering the therapeutic agents inside cholinergic nerve terminals.

DESCRIPTION: Botulinum neurotoxin (BoNT) is the most potent toxic substance known to mankind. The toxin causes a selective and nearly total inhibition of acetylcholine release from motor nerve terminals. Exposure to even minute quantities can produce muscle weakness, paralysis, respiratory arrest, and death. BoNT is a recognized threat agent that has been stockpiled by a number of hostile nations. Current treatments for BoNT intoxication consist of vaccination, infusion of a trivalent antitoxin, and respiratory support. At present, there are no specific approved therapies but efforts are underway both within the outside of DoD to produce such agents. A number of effective drugs (e.g., quinacrine, amodiaquine) have been identified by USAMRICD scientists, but their beneficial actions are limited by their high systemic toxicity.

PHASE I: Studies should be designed to develop nontoxic forms of BoNT that can deliver drugs to the nerve terminal, permit them to be internalized, and allow the drugs to become uncoupled from the altered BoNT vehicle. A modified recombinant toxin would be a reasonable starting point. The minimal components of BoNT that can successfully deliver drugs should be identified.

PHASE II: Studies should be focused on improving the delivery capability of the altered BoNT system. Thus, it would be more efficient if the BoNT light chain could be modified to include large numbers of repeating units for reversibly coupling drug molecules. Improvements should also be made in the coupling efficiency and in the ease of uncoupling once the drug-containing targeting vehicle has been internalized.

PHASE III DUAL USE APPLICATIONS: In addition to benefiting DoD personnel, the targeting system based on the use of botulinum neurotoxin (BoNT) fragments to deliver drugs selectively to the motor nerve terminal can be used to treat patients who are intoxicated by BoNT through ingestion of contaminated foods, contamination of wounds, or colonization of the large intestine by Clostridium botulinum organisms (infant botulism). Another commercial possibility for this product is in delivering therapeutic agents to cholinergic motor nerve terminals in neurologic conditions (e.g., Lambert-Eaton Myasthenic Syndrome) where acetylcholine release is insufficient. Modifications of this system can also be used to target the delivery of trophic substances to nerve terminals for accelerating regeneration of peripheral nerve injury.

A97-113 TITLE: Simplified Systems for PCR-based Diagnostic Assays for Infectious Diseases

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: To demonstrate technology for the (1) rapid preparation, (2) amplification and (3) identification of biological agent nucleic acid targets.

DESCRIPTION: Polymerase chain reaction (PCR) technology has enhanced our ability to detect and identify agents of biological origin (anthrax, plague, brucella, Clostridium sp., and more) and endemic infectious diseases (malaria, enteric diseases, dengue viruses, hantaviruses, Venezuelan equine encephalitis virus, Filoviruses, and more). Many of these agents are difficult to culture and can only be detected in biological specimens using nucleic acid amplification methods (hantaviruses). However, PCR and other genome amplification methods are confined to well-equipped molecular biology laboratories operated by experienced personnel. Emerging technologies are anticipated that will result in simple hand-held devices for use in the field or the first level of medical care (emergency room, troop medical clinic). Current techniques for rapid nucleic acid purification are multi-step and vary widely according to the milieu from which nucleic acid is being extracted.

For the first objective we require a rapid, relatively simple and efficient, method for DNA or RNA purification. Method/approach should be adaptable to a broad spectrum of specimen matrices. For pathogens of military significance, these samples may be biological specimens (blood, sputum, tissues, and feces) or environmental samples (soil, water, and air). Methods should have a low logistical burden, not require extensive instrumentation, and allow for greater than 60% recovery. Simple centrifugation methods are acceptable. Method/reagents should be adaptable for use in field or clinical environments.

For the second objective, we require specific nucleic acid detection methods that will allow rapid amplification of specific genomic or plasmid targets. Methods should have a low logistical burden and have the smallest foot print possible. Hand-held devices using micro-electromechanical technology have the highest priority. Instrumentation or approach may use either polymerase chain reaction technology or other isothermal amplification techniques. Proposed technology should be sensitive (greater than 95%) and specific (greater than or equal to 98%) for a broad panel of biological agents. For the third objective, we require methods for the rapid identification of amplified products. Proposed technologies should replace current gel electrophoresis methods of detection. Instruments or other methods that allow for rapid read out of PCR results would support

early intervention. Technologies that interface seamlessly with the above will be given the highest priority. The most favorable proposal will incorporate solutions for all three objectives.

PHASE I: Initial studies should provide a proof of concept for the preparation and rapid identification of selected infectious agents. Emphasis should be placed upon technology that can be miniaturized, reducing the need for macro devices by at least 60%. Specific pathogens of interest include, but are not limited to, anthrax, plague, brucella, Clostridium sp., malaria, enteric diseases, dengue viruses, hantaviruses, Venezuelan equine encephalitis virus, and Filoviruses. Some government-supplied reagents are available for limited evaluations. Prototype devices and technologies will be made available for government evaluation and inspection.

PHASE II: After selection of optimal specimen and detection technologies, follow or efforts will be conducted to evaluate miniaturized devices in field or clinical situations. Proposed devices or technology will be made available for government evaluation and inspection.

PHASE III DUAL USE APPLICATIONS: There are universal applications for the proposed devices and technologies. Estimated size of the commercial diagnostic device market in the United States is over $5 billion per year. The ability to amplify DNA and RNA by a rapid simple isothermal method would be nearly as revolutionary as PCR has been. The cost savings to research facilities realized from equipment not purchased would make this an extremely desirable technique. Kits containing proprietary reagents and protocols would be broadly accepted by the research community currently using PCR.

A97-114 TITLE: Stable, Specific, High-Affinity Binding Molecules for ELISA-like Detection of Selected Toxins and Infectious Disease Pathogens

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Design and test small, stable, low cost, specific, high-affinity binding molecules as potential replacement for capture and/or reporter antibodies in immunoassays (ELISA or chromatographic detection assays.)

DESCRIPTION: Enzyme-linked immunosorbent assays (ELISAs) and chromatographic detection assays use large, relatively unstable antibodies for the capture and detection of pathogens and selected toxins of military interest. These antibodies are generally polyclonal, multiple individual antibodies recognizing many epitopes. The polyclonal antibodies will have some variability from preparation to preparation. The use of animals for these preparations also increases the cost and animal use concerns. We require small, potentially synthetic capture/reporter molecules for use in ELISA-like detection.

These molecules should be stable for long shelf-life and shipping at ambient temperatures. They must be specific for selected toxins and infectious disease pathogens, binding them with high affinity. The production should be simple considerably less expensive than current antibody production.

PHASE I: Demonstrate the feasibility of production of a small, stable, low cost, specific, high-affinity binding molecule for use in ELISA and ELISA-like detection methods. Reagents should be prepared for at least two of the following pathogens of military concern: Yersinia pestis, Bacillus anthracis, clostridia toxins, Venezuelan equine encephalitis virus, Coxiella burnetii, or ricin.

PHASE II: Follow-on efforts will be conducted to evaluate proposed regents in the field or clinical situations. Reagents will be prepared against an expanded list of agents (10 total) as identified by the government. Sensitivity and specificity of proposed reagents in specific detection devices will be determined. Proposed reagents will be made available for government evaluation and inspection.

PHASE III DUAL USE APPLICATIONS: Detection devices that are inexpensive, simple, rapid stable and specific have application throughout the medical veterinary and environmental testing community. Cost savings in eliminating antibody production would be significant contribution to testing and detection efforts. The potential of the product as an inhibitory, therapeutic and/or prophylactic drug could have world health implications.

A97-115 TITLE: Toxicity Test Kit Development

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Develop and field a mechanistically-based toxicity test capability for use in the hazard assessment of new Army chemicals and contaminated sites in the environment.

DESCRIPTION: There is a need to develop rapid, inexpensive, accurate mechanistically-based toxicity test kits for the assessment of new chemicals being developed by the Army and the civilian community. The data developed from the use of these kits will be extremely useful in providing rapid early assessment of carcinogenic, developmental, immunotoxicologic,

neurotoxicologic, and reproductive toxic contaminants in either single chemical exposure scenarios or subsequent exposures to complex environmental contamination.

PHASE I: Development of test procedures and proof of concept for at least three different toxicity endpoints.

PHASE II: Validation of test procedures and construction of a prototype test kit.

PHASE III DUAL USE APPLICATIONS: Toxicity test kit technology developed under this SBIR project could be used commercially to provide accurate, short-term, inexpensive toxicity assessment methods for the identification of chemical hazards found in the environment. This technology could be used by both government (Federal, state, and local) and private-sector organizations to assess environmental and human health hazards caused by environmental chemical contamination.

A97-116 TITLE: Blood Processor for Donated Blood

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: To develop a closed system device to glycerolize blood in an automated, controlled fashion.

DESCRIPTION: The medical device shall be designed to automatically add glycerol to donated blood in a closed sterile system, filter as required, wash out any Free Plasma Hemoglobin, and display output blood chemistry parameters. This device will eliminate the current open system, manual method, which is erratic, often resulting in poor quality units of glycerolized blood. The machine design should be universal and flexible so that it can be adapted to other blood processing procedures.

PHASE I: Investigate feasibility and fabricate a laboratory prototype.

PHASE II: Fully develop the blood processor and obtain FDA licensed approval.

PHASE III DUAL USE APPLICATIONS: Produce and market the blood processor to DoD and commercial blood banking.

A97-117 TITLE: High-Impedance, Dry Physiological Recording Electrode

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Develop a physiological recording electrode that can be used in operational environments without requiring extensive skin cleaning, abrasion, and preparation. This electrode should be of a type that can be feasibly mounted inside of an aviator helmet.

DESCRIPTION: Traditionally, the monitoring of human physiological data has required that electrodes be attached to the skin with adhesive collars, tape, or collodion after the skin has been vigorously cleaned to reduce impedance. Low-impedance contacts have in the past been necessary to obtain artifact-free data. This approach is both time-consuming and troublesome, but feasibility was not a problem since physiological data were only collected in a laboratory environment. However, with the advent of small, portable, physiological recording devices, it has become possible to record data from personnel performing in the operational environment. Soon it should be feasible to conduct routine, real-time monitoring of a variety of personnel including aviators and aircrews in the cockpit. However, a recording electrode is needed that does not require vigorous skin preparation on the part of the person to be monitored. A helmet-mountable, high-impedance electrode would be ideal.

PHASE I: Research the problems associated with high-impedance recording electrodes and determine whether it is feasible to develop and utilize an electrode of this type to make physiological recordings under field conditions. Explore the design of such an electrode and develop a strategy to create it and prove it works.

PHASE II: Develop a prototype high-impedance electrode and perform comparison studies (in the laboratory and the field) which prove comparability between the new electrode type and standard physiological recording electrodes.

PHASE III DUAL USE APPLICATIONS: Develop a high-impedance electrode for the consumer market that can be used in a variety of settings. Create different types and sizes of electrodes for specific applications. Mount electrodes in helmets, headbands, and other articles that can easily be donned by research subjects and personnel working in real-world environments.

A97-118 TITLE: Aircrew Management Device

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Develop a miniaturized device (the size of a wrist watch) to: 1) record the user's sleep/wake cycle, light/dark cycles, and work schedules; 2) produce sleep management and daylight exposure schedules designed to minimize sleep loss and

performance degradation during shiftwork rotations and/or travel across time zones; 3) identify clock times in which safety will be compromised; and 4) prescribe the best times for duty hours and for rest periods.

DESCRIPTION: The device design requires built-in peripherals which will record 24-hour activity rhythms and environmental light. Analog data from these peripherals will be digitized and stored in memory. Memory capacity should allow 24-hour recording for at least 10 consecutive days. Work schedules will be entered via input keys on the face of the device. Internal software will analyze activity rhythms and approximate the status of soldier s biological clock and predict times of the day in which degradation of performance and alertness may compromise safety. These red-zones will be identified on the face of the wrist-worn device over a 24-hour clock. A sleep management strategy also will be displayed on the face of the 24-hour clock indicating optimal times for daylight exposure, daylight avoidance, naps, sleep, and work.

The device will provide soldiers with specific sleep and daylight management plans, and an indication of when to avoid hazardous activities. The expert software will coordinate sleep and daylight management plans with expected duty hours.

PHASE I: Development of software to merge already existing code developed at USAARL with peripheral output and biological rhythms prediction software. Demonstration of the efficacy of the device prior t miniaturizing efforts. The software development will produce programs that can be used to design crew-rest plans for Army aviation personnel using limited inputs such as flight schedules, light-dark cycle data, and environmental conditions.

PHASE II: Requires the integration of software, peripheral devices, and crew-rest software on a device with the outward appearance of a watch. The critical aspect of this phase of development is to identify hardware that may allow the display of information on the face of a watch as well as easy access to user input (small key pads).

PHASE III DUAL USE APPLICATIONS: The aircrew management device can be used by shiftworkers in all civilian occupations, including those requiring travel across time zones.

A97-119 TITLE: Parallel Processing of Quantum Chemical Calculations

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: Novel utilization of computational chemistry as a critical element in the discovery process of new drugs to treat drug resistant infectious diseases.

DESCRIPTION: Modern methods of drug discovery utilize computer-aided drug design in which the 3-dimensional geometry of potential therapeutic agents is optimized and the electronic properties of these compounds such as dipole moments, electrostatic surfaces, isopotential surfaces, lowest unoccupied molecular orbitals, and highest occupied molecular orbitals are calculated. These geometric and electronic properties are then optimized to design drugs which will specifically interact with a target receptor with high potency. The best information is usually obtained from ab initio quantum chemical calculations either in vacuo or using an aqueous solvent model to simulate biological conditions. At present there are no commercially available software programs which will take advantage of the DoD National High Performance Shared Resource Centers parallel processors. To perform these calculations with parallel processing would greatly enhance the drug discovery program in two ways: reduce time of calculations from weeks to minutes and allow calculations to be preformed on larger atom problems than can currently be performed.

Our anticipated requirements are for three kinds of calculations, semi-empirical, Hartree-Fock self-consistent field and DFT (density functional theory), using the basis sets STO-3G, 3-21G, 6-31G, 6-31G(d,p), 6-311G(d), and 6-311G(d,p). We also require geometry optimization.

The program or programs should run on as many of the following parallel machines as is reasonable: TMC Connection Machine, SGI Power Challenge, IBM SP2, Cray T3D, Cray T3E, Intel Paragon, and Convex Exemplar.

PHASE I: Write the computer code so that quantum chemical calculations can be performed on a high performance computer with parallel processing.

PHASE II: Optimize the computer code to take advantage of parallel processing, thus allowing calculations to be performed at a speed unmatchable by computers without parallel processing.

PHASE III DUAL USE APPLICATIONS: This enhanced software product should have broad commercial appeal to both industry and university groups involved in the design of future medicinal and agricultural products as well as material scientists designing new alloys, propellants, and explosives.

U.S. Army Space and Strategic Defense Command (SSDC)

A97-120 TITLE: Innovative Decision Aid

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop an innovative process that will take data from past experience and a wide range of current disparate sources as input and recommend a best decision to a human operator or military commander.

DESCRIPTION: This is not a new problem; however, the information age and digitization of the battlefield have intensified the need for a solution. Artificial intelligence, neural networks, data fusion, fuzzy logic, and other technologies are potential sources of solutions in this area. Using one or more of these is not ruled out here, but a new, innovative architecture is sought. The process should be able to prioritize, compress, and fuse the data. Then the process should make a recommended best decision based on the inputs and previous experience. The process should be robust; that is, it should be able to make the best recommendation most of the time, even with missing or incorrect data. The process need not run on a digital computer for maximum performance. The process should be based on science, but mathematical proof is not required if it works.

PHASE I: Show the feasibility of the process by simulation or other means. While innovative technologies sometimes do not have an available market, any potential markets and/or customers should be identified. Be specific in problem identification and solution.

PHASE II: Implement the process studied in Phase I. Develop the hardware/software necessary to demonstrate the process.

PHASE III DUAL USE APPLICATIONS: Personnel faced with making decisions in limited time and based on large amounts of data may be helped by this decision aid. Airline pilots, power station operators, air defense tactical operations center commanders, military commanders, manufacturing plant managers and others may be candidates for this product.

A97-121 TITLE: Reduction of Coincidental and Intentional Electromagnetic Interference in Commercial-off-the-shelf (COTS) Electronics

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Identify, develop, and demonstrate low-cost techniques to isolate electronic systems from external radio frequency (RF) interference.

DESCRIPTION: The expanded use of commercial-off-the-shelf (COTS) equipment in military systems leads to increased probability that electronics will be operated in RF environments that are more severe than those for which the equipment was designed. We desire to extensively use COTS equipment, but still have confidence that it can quickly, cheaply, and easily be modified to meet operability requirements on the battlefield. Proposed RF countermeasures must work in real time, but maintain system operability in the presence of friendly and hostile RF emissions. It is desired to be able to mitigate the effects of external wide band noise, nuclear electromagnetic pulse (EMP), non-nuclear EMP (which might have a higher frequency content than nuclear EMP pulses), and continuous emissions from both friendly systems and hostile jammers/weapons countermeasures. We desire generic solutions for mitigation of RF effects from pulse and Continuous Wave (CW) sources. Classes of systems for which mitigation techniques are sought include computers, communications equipment, radars, and missile electronics. The RF effects mitigation techniques may be based upon hardware or software techniques, or a combination of these.

PHASE I: Analyze, design, and conduct proof-of-principle demonstrations of the effectiveness of techniques to ensure operability of electronics in the presence of external RF emissions.

PHASE II: Develop operable prototypes and conduct tests to evaluate performance of the protected equipment in the presence of disturbing RF environments. Evaluate the effectiveness and confidence of proposed RF effects mitigation techniques and prepare detailed plans for implementation in an appropriate military or commercial application.

PHASE III DUAL USE APPLICATIONS: There is a very large potential market in the commercial electronics industry for electronic systems which will remain operable in the presence of increasingly severe peacetime RF environments. In addition, once these techniques are applied to commercial electronic equipment, the equipment should not be susceptible to deliberate (terrorist) RF threats.

A97-122 TITLE: Error Modeling of the ALTAIR Real-Time Refraction Correction Model

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop and implement algorithms for estimating the uncertainties in the refraction corrections provided by the new refraction model used in the Advanced Research Projects Agency (ARPA) Long Range Tracking and Instrumentation Radar (ALTAIR).

DESCRIPTION: The objective of this effort is to define and implement algorithms for estimating the uncertainties in the refraction corrections provided by the new model used in the ALTAIR radar. These estimates are needed to determine the accuracy of the true positions of orbital objects estimated from the radar's measurements. A new refraction correction model has recently been installed at ALTAIR to provide corrections in range and elevation at Ultra-High Frequency (UHF) and Very-High Frequency (VHF) when tracking is possible at only one frequency. This model uses a standard mean tropospheric model and a parameterized ionospheric model (PIM) to determine a hemispheric index of refraction. The model is corrected using Global PositioningSystem (GPS) Total Electron Content (TEC) measurements, radar dual-frequency or incoherent backscatter measurements, and ionosonde measurements from the previous few minutes if they are available. Results of ray tracing are stored in lookup tables for real-time use. New tables are generated periodically throughout the day. The accuracy of the corrections depends on many factors such as the accuracy and completeness of the models, the availability of measurements of parameters used by the models and the calibrations of the instruments used to measure the parameters such as the calibrations of the radar, GPS satellites, and GPS receivers. However, unpredictable spatial and temporal variations of the transmission media limit the accuracy that can be achieved by this approach.

PHASE I: Identify and quantify the sources of error in the current ALTAIR model. Isolate the basic parameters associated with different errors and determine whether any significant errors can be reduced by improvements in the models or measurements. Determine the bounds on errors arising from physical processes that cannot be modeled as a function of solar cycle phase, season of the year, and time of day.

PHASE II: Develop and implement algorithms and software that can provide real-time estimates of the measurement uncertainties including, if possible, determining scintillation conditions and account for their effects. Assist in the integration of this software with the ALTAIR refraction model software.

PHASE III DUAL USE APPLICATIONS: The enhanced precision should be of benefit to any radar operating at frequencies below UHF.

OPERATING AND SUPPORT COST REDUCTION (OSCR) INITIATIVE TOPICS

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A97-123 TITLE: Small Photon Battery

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop a safe, small, photon battery which has a very long service life and a wide operational temperature range as required in military fire control applications.

DESCRIPTION: The photon battery required will use a radioisotope as a primary source in a photo-electric conversion process. Tritium will be the radioisotope, and the battery will depend in part on electron energy from beta decay. The beta radiation first produces a photon through a physical interaction of a beta electron and a luminophor (i.e. phosphors). The photon bombardment of a semiconductor material creates the electron hole pair and electrical potential across a junction. This conversion will provide a continuous DC supply. The power source will use a photovoltaic array and self-luminous microlamps. In order to improve battery storage capacity the tritium gas will be enclosed under high pressure in tiny low-diffusion glass capsules each containing phosphors. A battery power level of 100 microwatts or more per cubic centimeter is desired. This solicitation is for development of a safe, low-cost, long-life battery which will be a significant improvement over status quo chemical batteries and early beta cells. The new battery will pose minimal needs in terms of special safety and operational considerations.

PHASE I: Develop methodology for design and implementation of a system which will result in a power source using beta radiation from radioluminescent microencapsulants for improved battery storage capacity. Included will be labor to develop methodology for creating the photon battery conceptual designs for at least two military fire control applications.

PHASE II: During Phase II the contractor will design, fabricate, and test three sample photon batteries. The units will be for a military fire control application. The units will be tested for required electrical performance, and be subjected to the environmental extremes required for fire control equipment.

PHASE III DUAL USE APPLICATIONS: Since the small photon battery (similar to a "D" size battery) would be a low-current, long-life, hermetically sealed unit, it would have many applications in powering parts of electronic equipment used in space missions where volume and weight are at a premium. The beta battery will be an attractive alternative to chemical batteries, which do not work well in space. The new battery will endure for years in harsh industrial environments with no change in output performance characteristics. There will also be applications in powering long-term monitoring sensors used in industry.

OPERATING AND SUPPORT COST REDUCTION: The "Small Photon Battery" program is an Army OSCR candidate. The non-chemical "D" size battery will be applied to Army systems as a commercial technology insertion. Sustainability developed technologies, i.e., materials, components, processes and practices will be applied as required into the photon battery development effort. According to the Assistant Secretary of the Army for Research Development and Acquisition and the Chief of Staff of the Army, battery costs must be reduced by 50% and new weapon systems must have either rechargeable batteries or batteries that will last 5 years or longer. The proposed Photon Battery will exceed these Army requirements. The Photon Battery will result in clearly needed improvements in war fighting capabilities of 21st Century Fire Control systems being developed for the advanced artillery, mortar and tank systems. Improvements will also be realized in fire control battery availability, sustainability, safety, health and environment. These major programs will realize life cycle savings of over 30 percent by employing photon (install & forget) power systems which will last longer than the weapon systems on which they are employed.

A97-124 TITLE: Thermal Protective Coatings/Materials for Packaging Applications

KEY TECHNOLOGY AREA Materials, Processes and Structures

OBJECTIVE: Develop thermally dissipative coatings or materials that can be applied or inserted into packaging (primarily munitions) that can dissipate heating from solar radiation with little or no increase in packaging size and weight and military coloration.

DESCRIPTION: An easily applied solar protective coating would have a large commercial application in United States industry while aiding the DoD in improved service life for packaged munitions. Solar radiation causes elevated temperatures during transportation and storage of a multitude of items increasing the costs of refrigeration and causing products to have a reduced shelf life during the summer months. Development of a solar protective coating would find a wide market because the reduction of solar heating would pay for itself in reduced energy costs and improved products. The hazardous materials industry would also be a ready market for a solar protective coating due to improved safety during transport and storage of a wide range of hazardous materials. The solar loading of large storage tanks and tank cars can generate large pressures inside through solar

heating requiring costly thermal regulation devices and the release of hazardous materials through pressure release valves. A solar protective coating applied to these facilities would increase safety, reduce energy costs and reduce potential environmental problems. Finally, there would be a market for solar protective coatings that are easily applied in other industries and applications such as construction (reduced energy costs for climate control, reduction in thermal expansion for large structures such as bridges) and the chemical and food processing industries (coating of temperature sensitive processing piping and fixed apparatus for both reduced energy costs and better thermal management of processes). The commercial applications of a solar protective material are far ranging and would find a ready market therefore reducing the costs for the DoD and improving the service life of packaged munitions items.

PHASE I: Develop and apply to provided military packaging samples thermal protective coatings or materials. Demonstrate through the use of solar chambers, or actual solar exposure, the ability of the selected materials to mitigate solar radiation against identical control packages without the protective features.

PHASE II: Develop product descriptions and develop application methods suitable for a production environment. Provide containers with the solar protection features to a quantity of containers for large-scale demonstrations on problem munitions.

PHASE III DUAL USE APPLICATIONS: An easily applied solar protective coating would have a large commercial application in United States industry while aiding the DoD in improved service life for packaged munitions. Solar radiation causes elevated temperatures during transportation and storage of a multitude of items increasing the costs of refrigeration and causing products to have a reduced shelf life during the summer months. Development of a solar protective coating would find a wide market because the reduction of solar heating would pay for itself in reduced energy costs and improved products. The hazardous materials industry would also be a ready market for a solar protective coating due to improved safety during transport and storage of a wide range of hazardous materials. The solar loading of large storage tanks and tank cars can generate large pressures inside through solar heating requiring costly thermal regulation devices and the release of hazardous materials through pressure release valves. A solar protective coating applied to these facilities would increase safety, reduce energy costs and reduce potential environmental problems. Finally, there would be a market for solar protective coatings that are easily applied in other industries and applications such as construction (reduced energy costs for climate control, reduction in thermal expansion for large structures such as bridges) and the chemical and food processing industries (coating of temperature sensitive processing piping and fixed apparatus for both reduced energy costs and better thermal management of processes). The commercial applications of a solar protective material are far ranging and would find a ready market therefore reducing the costs for the DoD and improving the service life of packaged munitions items.

OPERATING AND SUPPORT COST REDUCTION: The service life of munitions is reduced by exposure to high temperatures especially in the propellant area. Prolonged high temperatures accelerate the loss of propellant stabilizer causing the munitions to become unserviceable and requiring renovation. By reducing the long term temperature exposure of packaged munitions items, the stockpile will remain in a serviceable status longer and require less maintenance and surveillance during its lifetime.

A97-125 TITLE: Automated Tomographic Inspection of Munitions

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop, fabricate and deliver a system which automatically identifies defects in or determines the condition of munition items using x-ray computed tomography.

DESCRIPTION: Recent advances in x-ray sensors and tomography make it possible to develop a system which can make autonomous decisions automatically and rapidly enough for the manufacturing environment. ARDEC has the requirement to inspect and to develop inspection methods for numerous and differing munition items, ranging from electromechanical devices such as 20 mm fuzes to 155 mm projectiles. Inspection must find cracks, porosity voids, misplaced components, and a host of defects arising from the manufacturing process. This solicitation is for the design, fabrication, and delivery of a tomographic system comprised of all the components for the overall system except the x-ray source. The system must acquire the x-ray signal, create tomographic images and radiographic images, automatically analyze the images for defect conditions, and display the results and the decisions. The system must be constructed such that the user can interact in an active way to teach the system the defect to be discerned. The system must interface with a host of x- ray sources already owned by ARDEC, including a 4 MeV and a 2 MeV Linatron, a 25 MeV Betatron, and 200, 250, and 300 KeV x-ray sources. The x-ray detector has to be designed so that stray or direct radiation does not cause deleterious effects. The user interface and other electronics will be fifty feet, more or less, from the detector and in another room. The system needs to be generic in nature and very versatile in application. Versatility is more important than throughput for the ARDEC system.

PHASE I: The contractor shall design the system, select components, and prove the system will work in the ARDEC environment, and meet the described objectives.

PHASE II: The contractor will fabricate a prototype system, test it, redesign and rebuild until it meets the objectives. The system will be fabricated, tested, and left on-site at ARDEC. The deliverables will include full documentation, design documents, software source, and object code, with sufficient comments for maintenance by ARDEC personnel, operation manuals, and maintenance manuals.

PHASE III DUAL USE APPLICATIONS: Commercial and military applications will include most non-destructive inspections of manufactured items by tomography. Applications exist in inspection of munition items, automotive parts, aircraft parts, turbine blades, etc. Applications would include inspection of aging aircraft, especially turbines and other high stress components.

OPERATING AND SUPPORT COST REDUCTION: ARDEC's mission includes the inspection of many diverse items for the purpose of developing new inspection techniques and methods to be used by our manufacturers. ARDEC inspects all types of ordnance, especially of unknown origin, and inspects unexploded devices of unknown condition. This requires daily modification of inspection setups. It involves considerable trial and error, all of which takes time. Tomography, if implemented at ARDEC, will reduce its labor for both setup time and material handling. After proven to work at ARDEC, similar systems will be promoted for use at manufacturing sites of munition items resulting in even greater operation and cost savings.

A97-126 TITLE: High-Accuracy Speech Recognition In Noisy Environments

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Design and develop a flexible external module, for speaker independent continuous speech recognition/synthesis, that is usable in a high-noise, multi-peopled environment. Phase II results should translate to a practical implementation as a small portable plug-in microcomputer module that permits high accuracy, near real-time spoken language communications between an operator and an external system, in both a high noise and multi-peopled environment.

DESCRIPTION: Most current speech recognizers fall short when high background noise is encountered, and especially when other voices are present. Due to this shortcoming, operator/computer voice interaction has been slow in acceptance. What we need is a system that can extract the voice of a speaker from a signal cluttered with high levels of both continuous and impulse noises as well as other voices, and without attaching specialized microphones to the operator. This advance would make speech recognition usable inside armored vehicles, as well as in factories and in maintenance facilities.

PHASE I: The design of a module/system that is able to understand spoken statements, speak the responses, display all input and output on an internal display, and exchange data with an external computer. Speech output should be available to the operator via an internal speaker and headset. Any response or output should also be available to a desktop or factory automation host computer through a standard RS232 serial I/O port. Any text received through the serial port should be spoken by the system and displayed on the module's screen. Speech input should be via a standard audio port containing both a microphone and line level input. This system must be very resistant to accuracy degradation due to both continuous and impulse noises present within military armored vehicles and on factory floors, as well as from the presence of other voices. All recognition should be done in near real-time, but transcription accuracy, without the need for an operator to repeat statements, must have top priority.

PHASE II: Implement best approach on a portable microcomputer system test bed. Develop test scenarios and demonstrate the recognition system's ability to understand and respond, in near real-time, to spoken statements from various speakers in a variety of operating environments. Provide fully integrated prototype module, all required software to interface to external computers, complete documentation, source code, and the development environment.

PHASE III DUAL USE APPLICATIONS: Most computers have a variety of speech recognizers available... very few are used. Most simply emulate keystrokes or mouse clicks and do not permit true operator/system communications using speech. The results of this effort will result in the development of a product/system that will understand spoken language communications in near real-time, and in the natural communication style used between people. Since this system will be friendly to use, it will be used, and will permit easy operator control of all computerized systems, from desktop to factory automation. Since speech is a natural, flexible, and very high level means of communicating, this system will reduce operator training time, decrease operator response time, increase operator efficiency, and reduce the total number of required workers or crew size.

OPERATING AND SUPPORT COST REDUCTION: Since speech is an intuitive means of communications, it will reduce the training time required for a soldier to learn to operate a new system. It will decrease manpower costs by reducing the number of operators needed since a soldier, with his eyes and hands busy, will still be able to speak commands to the computer or weapon system. And, it will reduce the costs associated with human/machine interface, since speech commands can supplement many of the slow and cumbersome keyboard and push-button data entry procedures currently in use.

A97-127 TITLE: Advanced Nonlinear and Hybrid Systems Control Technology

KEY TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Develop algorithms, design methodology and processing architectures to support implementation and application of multi-agent intelligent controls technology to weapon platform automation and manufacturing applications. Demonstrate and validate technology for precision, automated fire mission engagement.

DESCRIPTION: Recently progress has been made in demonstrating enhanced fire mission performance for aircraft and combat vehicle applications using hierarchical finite state automata for intelligent discrete event control and advanced digital adaptive control for precision servo level control. Recent advances in hybrid systems control technology provide the opportunity to further extend performance by implementing explicit compensation for "hard" nonlinearities such as friction, backlash, hysteresis, saturation, etc. for low level servo controls and enabling high bandwidth, decision-in-the-loop control logic for distributed fire mission task automation. This project will address the broad spectrum of issues associated with the development of distributed, multi-agent control laws, supporting design and prototyping tools, real time hw/sw processing technology and hybrid modeling and simulation tools. Approaches should consider optimization/ Lagrangian based techniques, anytime planning systems, distributed object processing approaches, hierarchical finite state automata, petri nets, algebraic methods as well as heuristics to develop efficient computational approaches to dynamic resource allocation, scheduling, task planning/replanning, perception and real time control requirements associated with the generic multi-agent control problem and the multi-agent fire mission application in particular.

PHASE I: Develop methodology, computation approaches and architectural concepts to support design and implementation of generic distributed multi-agent control systems. To demonstrate the generic nature of the multi-agent framework and methodology, adapt the problem formulation to the distributed multi-platform- multi-target engagement application and also illustrate applicability to a second domain such as manufacturing or smart highway systems. Methodology should address issues associated with the construction of hybrid system models and the design and implementation of hybrid, multi-agent control laws that integrate low level servo control and sensory processing functions with high level task planning, perceptual reasoning, dynamic resource management and scheduling capabilities. Problem formulation should take into account physical constraints of sensor/ actuator subsystems as well as inter-platform communication and environmental constraints. In the case of the fire mission application such constraints would include pointing accuracy, maximum slew rates, rate of fire, sensor field-of-view, sensor resolution, atmospheric effects etc. Phase 1 effort will identify specific tools to support design, implementation and analysis and will address hardware/ software implementation requirements to achieve real time performance.

PHASE II: Develop a fully integrated design and prototyping environment to support generic multi-agent control applications. Develop generic algorithms, simulation drivers and hardware/ software to support real time implementation and testing multi- agent control laws. Develop application specific platform/ sensor models, knowledge bases and user interfaces necessary to evaluate multi-agent technology for fire mission applications. Optimize module hardware/ software and algorithm design based on test data and provide complete documentation of algorithms and hardware/ software architecture.

PHASE III DUAL USE APPLICATIONS: This work has a very high probability of being commercialized. The design methodology, prototyping tools, algorithms, computational architectures, and component implementation technology developed under this SBIR topic are applicable to manufacturing, precision machine tools, process control, engine control and automation applications, including automobile and commercial aircraft manufacturing, robotics, flight controls, smart highway systems, etc. These applications are characterized by the presence of discontinuous nonlinearities as well as the presence of discrete event and continuous time dynamics. This latter class of hybrid system models is quite general and arise in all applications involving the automation of decision and control processes, e.g. intelligent controls. The defense applications of this technology arise in all areas of smart weapons, robotics, defense manufacturing and command and control. The impact of the technology is two-fold: increased control performance and accuracy through improved software and reduced operating and support costs through automation, fault tolerance and on-line adaptation.

OPERATING AND SUPPORT COST REDUCTION: Technology developed under this topic will permit development of a low cost, common hw/sw module for all digital control and stabilization of gun/turret systems for ground and air platforms. Low cost digital hw/sw will replace complex analog circuitry, reducing development, maintenance and support costs for all conventional weapon systems while enhancing system accuracy.

A97-128 TITLE: Tele-Operated Mobile Fire Extinguishing System

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: Develop a mobile fire extinguishing system that can be remotely operated to fight fires in hazardous environments (e.g., environments with explosives and hazardous chemicals).

DESCRIPTION: The Army needs a capability to quickly extinguish fires in hazardous environments before they propagate and cause catastrophic damage and loss of life. In combating fires in ammunition storage areas, there is a need to be able to deploy remotely controlled fire fighting equipment because of the risk to human life. Because of this risk, current policy is to let fires run their course if one occurs. This system will enable human safety to be maintained while fighting the fire. The desired fire fighting system should:
-- have a self-contained storage reservoir of foam and water, and be remotely operator selectable;
-- provide visual information to the operator for remote control operations;
-- be able to draw upon external water reservoirs;
-- be able to direct a stream of water up to 100 feet or more;
-- be self-powered and remotely steerable;
-- be easily towable; and
-- fit within a standard 8' X 8' X 20' shipping container

PHASE I: Perform design studies and analyses as necessary to generate an overall viable system design and record all information in a final report.

PHASE II: Fabricate a complete functional prototype system and demonstrate its functionality.

PHASE III DUAL USE APPLICATIONS: This system would readily be usable by the commercial sector to fight fires that involve particularly hazardous substances such as explosives and toxic chemicals, minimizing human exposure to the environment. Such systems could be readily used to fight fires associated with highway, railroad, and aircraft accidents.

OPERATING AND SUPPORT COST REDUCTION: This system will provide a means to fight/prevent the propagation of a fire once it has begun, greatly reducing the probability of mass sympathetic detonations that destroy large portions of the ammo inventory at field storage sites. By greatly reducing the likelihood of mass detonations, the enormous OSCR costs associated with re-supplying destroyed ammunition are avoided.

A97-129 TITLE: Advanced Munitions Packaging Materials and Manufacturing Technology

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop low-cost and lightweight material and manufacturing technology for munitions packaging.

DESCRIPTION: Most existing munitions packages (containers) are made of heavy materials such as steel. Steel containers are heavy and will confine burned propellant gases. Gas confinement leads to explosions, and thus increases the hazard classification of the munitions and logistics burden. When explosions occur, firefighters cannot get near the flame source to put out the fire; hence, munitions and other supplies will ultimately be destroyed. In addition to safety and logistics problems, there is the issue of replacing the munitions. One solution to the safety, logistics, and cost problems is to develop new technologies to produce low-cost, lightweight, and low melting point containers. The purpose of using low melting point materials is to enable release of burned propellant gases.

All munitions packaging must meet the following environmental requirements: Survive leak, vibration, and drop tests at -65□ to 160□ F temperature range; and survive humidity, salt spray, chemical compatibility, NBC (nuclear, biological, and chemical), and solar radiation tests. The packaging material must not create fire hazard, must have low melting point to prevent explosions, and must be environmentally benign. The container must have a 20-year shelf life.

PHASE I: Review current munitions packaging requirements. Investigate existing materials and manufacturing technologies. Select alternative materials and develop package design supported by engineering analysis. Fabricate and deliver prototype packaging system and a final report. The final report shall include a Phase II proposal.

PHASE II: Develop prototype test plan and hardware. The test plan must meet the Army munitions package test standard, and must be reviewed and approved by the appropriate government agency. Conduct test in accordance with the approved test plan. Conduct program review and submit monthly report. Deliver two (2) prototype packages and a final report to the government. The final report shall include a Phase III proposal.

PHASE III DUAL USE APPLICATIONS: The technologies developed under this program will produce low cost, lightweight, and reduced hazard packaging designs for commercial products that are heat sensitive and will explore under fire because of the existing container heavy confinement design. Reduced hazard thus improves the public safety and prevents the loss of lives and property. The technologies will applied to the packaging designs for products such as commercial explosives, agricultural materials, electrical equipment, chemical and many hazardous materials.

OPERATING AND SUPPORT COST REDUCTION: Containerization and Packaging, improvements are needed in the technology used to optimize load configurations in CONUS, to rapidly plan ship loading and stowage, to identify and develop intermodal and multimodal platform concepts, and to increase efficiency of material handling equipment (MHE) that is

positioned to handle containers. There is a requirement for "smart" packaging that is recoverable, recyclable, lightweight, with little or no dunnage, and capable of being decontaminated and monitored for integrity and environmental parameters (e.g. susceptibility to temperature, moisture, etc.) thereby reducing handling and maintenance costs.

A97-130 TITLE: Magnetic Sensors for Electronic Fuzes

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop magnetic sensors and signal conditioning technology for next-generation fuzing systems. Appropriate technology candidates must enhance safety, reliability, and producibility in order to be considered for fuzing systems.

DESCRIPTION: Typical fuzes consist of sensor, signal processor, power supply, and safety and arming subsystems. A fuze must not only endure decades of storage in adverse conditions, but must also withstand extreme ballistic launch environments and still function reliably at the intended target. Not only is fuze performance critical, but cost is also extremely important because fuzes may be produced in large quantities for the military stockpile.

Magnetic sensors are required to perform two different functions for electronic fuzing. One function, as a safety element for non-spinning rounds, is to sense that a projectile has properly exited from a gun tube and to send this information to the fuze's safety and arming device. The other function, in the case of a spinning projectile, is to initiate the projectile warhead in the post-launch environment by counting the number of projectile revolutions so as to determine the distance from the gun to the desired burst point. These functions are independent of each other and thus may not be employed on the same fuze.

The magnetic sensor should be able to detect a minimum detectable field of 0.02 Oe, that is one-tenth of the earth's minimum magnetic field. Existing coil-based and Hall Effect magnetic sensors do not have the required sensitivity. The offset and hysteresis signals generated by the sensor should not obscure the desired signal. If exposed to a strong external magnetic field of 1000 Oe, the magnetic sensor should recover and continue normal operation within 10 mS after the field is removed. Temperature/environmental stability and self- generated "noise" should be addressed in the proposed effort. The operating temperature range for a typical fuze is from -50 to +145 degrees Fahrenheit. The storage temperature range is from -65 to +160 degrees Fahrenheit. The sensor should have a signal bandwidth from 0 to 500 kHz, at a minimum. The sensor output should be compatible with commercial CMOS logic using a power supply Vdd from +3 to +5 Volts. A scaled analog output would be a desirable test connection for laboratory sensitivity measurements. The power consumption of the magnetic sensor should be low because in some cases, fuzes are powered only by a charged capacitor. The basic sensor and signal conditioning electronics should be implemented in an integrated circuit (IC) and not require any magnetic biasing components such as permanent magnets for operation. However, in the safety element application, a permanent magnet may be used in conjunction with the magnetic sensor IC to increase the number of magnetic flux lines available for sensing the gun tube. The gun tube may be up to 2 inches away from the magnetic sensor in a fuze. For the turns counting application, the magnetic sensor needs to provide the fuze with the number of turns accurately enough so that the range from the gun can be determined to an accuracy of +/-0.5% out to a maximum target range of 1 km. Small size, gun or missile launch survivability, and low cost are principal driving requirements. Sensors must also be able to withstand electromagnetic environments without causing a safety or reliability failure. Mission Relevance: Military applications for magnetic fuzing and safety devices include conventional non-spinning munitions such as tank cartridges (M830A1), mortar cartridges (XM984), smart munitions (STAFF), rockets (Extended Range Multiple Launch Rocket System), guided missiles (TOW upgrades), and anti-tank land mines (Wide Area Mine). Spinning rounds include 20mm class cartridges such as Objective Individual Combat Weapon (OICW) and Objective Crew Served Weapon (OCSW). Other programs that could benefit from this technology include non-lethal defense and low-collateral damage munitions.

PHASE I: Identify promising magnetic sensor technologies. Perform a cost and producibility analysis, up front, to predict if it is feasible to fully develop and produce the technologies. Conduct modeling and simulation to predict the performance of selected candidates under realistic conditions. Fabricate breadboard models and perform laboratory tests on them to confirm the predictions of the models. Submit samples to the Government for in-house evaluation.

PHASE II: Implement technology from Phase I effort into actual fuze hardware. The fuze hardware will be evaluated by subjecting it to standard fuze laboratory environmental and ballistic simulation tests. If lab tests are successful, another set of fuze samples will be fired from a weapon in an instrumented ballistic field test. The prototype designs shall be optimized for producibility and cost. Detailed design drawings and specifications shall be developed.

PHASE III DUAL USE APPLICATIONS: Sensitive magnetic sensors that are low-cost and precise can provide position and counting outputs. These have a wide variety of commercial applications, including: electronic compasses for automobiles and other ground vehicles, motion/metal detectors for alarm systems; and position/motion sensors for robotic and automated industrial systems, as well as medical equipment.

OPERATING AND SUPPORT COST REDUCTION: The magnetic sensor technology solicited in this topic will enhance safety, reliability, and improve the lethality of ammunition. Improved ammunition will mean that less of it will be required in both training and warfare to defeat the target set. This implies a savings in training costs and logistics costs for storage and

transportation of the ammunition to the usage site. The magnitude of these savings are impossible to quantify at this time because improvements to fuzing apply across the spectrum of weapon systems and it is too early in the development life cycle. Fuzes with enhanced magnetic sensors have not begun to be designed because there is no technology available to insert yet. Ammunition fuzes are designed to have a shelf life of a minimum of twenty years with no maintenance to the end item. In training or warfare, the fuzes are removed from their packing material by the user, mated with cartridges (if the ammunition is not prefuzed), set for the fire mission and fired from the weapon. For fuzes as an end item, there is therefore no "maintenance" cost to reduce, because there is nothing to service or repair while the fuzes are in storage. There may be maintenance on the ammunition cans or overpacking but this is not relevant to the subject of this topic.

A97-131 TITLE: Moisture-Proof Coatings for Composite Materials

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop production-compatible moisture and high temperature gas impermeable thin film coatings for complex-shaped carbon fiber composite materials.

DESCRIPTION: Carbon fiber composite materials are presently being used in newly-developed and experimental sabots for kinetic energy projectiles. Recent experience has shown that these materials are susceptible to levels of moisture achievable in the field. There is also evidence that small voids in the composite become pressurized during gun launch, causing failure of the material in the near out-of- bore region. Any coating developed should be a bar to these materials, with moisture being the highest priority. The coating should be thin, because there are complex mating surfaces, should not inhibit the bonding of non-metallic "rubber" boots, be compatible with depleted uranium and typical propellant materials, and be capable of application in a typical ammunition production facility.

PHASE I: Develop coatings, or a family of coatings, with prototype application hardware. Demonstrate the properties of the coatings via laboratory tests with coupons (to be provided). Conduct moisture tests to demonstrate moisture proofness. Test compatibility and non-metallic materials adhesion properties. (Depleted uranium compatibility test to be done at the U.S. Army Armaments Research, Development and Engineering Center (ARDEC)).

PHASE II: Coat full-scale Government Furnished Material (GFM) sabots which will be assembled into projectiles for full-scale humidity and ballistic testing. All components and assemblies except the coating(s) and application will be GFM, as will the testing. Prepare design of production application equipment.

PHASE III DUAL USE APPLICATIONS: Composites are widely used in the aircraft industry and moisture intrusion is a problem. A successful coating, particularly one which does not inhibit bonding of adhesives, will have wide application.

OPERATING AND SUPPORT COST REDUCTION: This effort will result in the development/application of surface treatments to retard or prevent the intrusion of moisture into composite ammunition components. This capability will enhance the application of composite materials in situations where corrosion couples are very active and where dimensional stability is critical. It is expected that the spin-off from this work would be available to any composite application.

A97-132 TITLE: Development of a Long-Wave Infrared Imaging Spectroradiometer

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop a Long Wavelength Infrared (LWIR) imaging spectrorediometer for use in Non Destructive Inspection (NDI).

DESCRIPTION: Imaging spectrometry allows for identification and discrimination of objects throughout an image based on material-driven spectral characteristics. The Army is currently developing a mid-wave infrared imaging spectroradiometer, and would like to complement that instrument with an LWIR imaging spectroradiometer. This instrument would need to acquire spectral imagery of at least 256 x 256 pixel spatial resolution at approximately 2% spectral bandwidth. The spectral imagery must then be processed to produce calibrated spectral radiances at each pixel in the image. Further processing should be capable of identifying objects throughout the image based on material- driven spectral characteristics. Data collection and processing must occur in real-time.

PHASE I: Investigate feasibility of an LWIR imaging spectroradiometer, its specific NDI applications, and develop a preliminary design for such an instrument. The contractor shall find potential sources of capital for commercialization and production.

PHASE II: The contractor shall build and deliver the prototype system designed in Phase I, test it, document its operational characteristics, validate its worth with real NDI applications, and design a production version.

PHASE III DUAL USE APPLICATIONS: Commercial and military NDI applications include imaging variations in material composition of composites, ceramics, plastics, propellants, paints, films, and gases. Non-NDI applications include body fluid analysis, infrared imaging, planetary imaging, earth science imaging, pollution monitoring, motor plume analysis, etc.

OPERATING AND SUPPORT COST REDUCTION: Identification of chemicals on the surface of objects, identification of chemical composition, and identification of chemicals in the atmosphere can often be done from the infrared spectral content of the material. Identification methods currently used involve wet chemistry with considerable effort for sample acquisition, sample preparation and chemical analysis. The spectral bands of interest range from the near IR to far IR, with the bands of most interest in the far IR. The proposed system will be used to develop new methods to replace wet chemistry and if produced in quantity could be used for analysis procedure itself. Laboratory spectrometers have been used to develop the new IR methods but the procedure takes months. The proposed system will facilitate the development of new methods in days and provide the actual instruments for regular use. Cost savings from reduced labor, chemical handling, and execution time will be reaped in both the development of the new methods and the regular performance of the new method.

U.S. Army Research Laboratory (ARL)

A97-133 TITLE: Innovative Fuel Cells

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop and demonstrate more energetic/efficient, inexpensive, lightweight, fuel cells, and fuel cell stack components.

DESCRIPTION: Steadily increasing mobile electric power requirements have increased the need to develop more efficient and more energetic power sources. Very lightweight, long-lived power sources for "Individual Soldier" applications have been traditionally met with primary or rechargeable batteries possessing power densities in the 50 Watts/Kg range and energy densities in the 300 watt-hours/kg range. Backpack 100-300 watt fuel cells are seen as a preferred approach for achieving system energy densities towards the 1000 watt-hour/kg range. Innovative concepts in fuel cell chemistries, materials of construction, and cell and stack design are required to provide a significant increase in deliverable power density together with a considerable decrease in overall system cost, weight, and complexity. Our present emphasis is on applications which require 1-100 watts and could be carried by one person, thus implying PEM or other ambient- temperature technology.

Proposals would be considered in, but need not be limited to, one or more of the following areas: use of alternate fuels, e.g., methanol, ammonia, hydrocarbons; design of novel fuel storage/delivery systems, e.g., lightweight hydrogen generators; and substitution of lightweight/less costly/more efficient materials, e.g., new/composite PEM, improved/novel catalysts.

PHASE I: Identification of new materials or components. Sufficient characterization (including in prototype laboratory cells) to demonstrate potential usefulness.

PHASE II: Complete development of materials or components and fabricate/demonstrate prototype fuel cell and/or fuel stack.

PHASE III DUAL USE APPLICATIONS: Small fuel cell systems are potential power sources for many modern electronic and electrical appliances, including camcorders, laptop computers, and portable electric tools.

OPERATING AND SUPPORT COST REDUCTION: The development of lighter, less expensive fuel cells with greater capacity for energy storage has obvious potential for operating and support cost reduction. These savings could be realized in both the military and commercial arenas. As individual soldier systems require more power, fieldable man portable systems become a greater necessity. Non-military uses include power tools, lighting systems, portable computers and a multitude of electronic and electrical apparatus.

A97-134 TITLE: Smart Fluids

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Since 1940, when Willis M. Winslow first observed the effect, it has been known that the viscosity of fluids containing suspended particles can be changed by orders of magnitude when a strong electrical field is applied. Thus, these fluids have constitutive behavior characteristic of a fluid or that of a solid, depending on the applied field. The explanation of the effect is based on the fact that the particles in the presence of a field link together, congealing the fluid. Electrorheology, as the field is known, has attracted attention over the years, but a successful commercial product has yet to be marketed. Research in the U.S., Europe, and especially in Japan has continued. In the U.S., the Chrysler Corporation is working on an automatic transmission using an electrorheologic design and Monroe has tested shock absorbers using so-called smart fluids. There is also

keen interest in the field of robotics. Other potential applications include ultrafast hydraulic valves and control actuators. The advantage for these devices is that with the elimination of mechanical motion, response is almost instantaneous. It is the objective of this SBIR topic to invite proposals to assess the potential of this field and propose applications for land warfare.

DESCRIPTION: There are several areas in this field where technology maturation for the realization of practical applications needs to be assessed. Among these, the following would merit special attention:
1. Explanation of the details of the Winslow Effect. This includes aggregation kinetics, chain cross-linking, and scaling.
2. Means need to be found to prevent electrorheologic emulsions from breaking down.
3. Research on the "best" candidate materials to achieve the maximum electrorheologic effect. Among the new materials studied are liquid crystals which also undergo alignment in electrical fields.
4. Design of devices for land warfare exploiting the advantages conferred by the Winslow Effect.

PHASE I: During the initial phase, the best candidate materials, and combinations of liquids and particles would be identified. This would include an assessment of electrical properties, particle sizes and best response as a function of applied field strength. Also, impediments to the development of devices based on electrorheology would be identified.

PHASE II: Using the information developed in Phase I, prototype device(s) would be constructed and tested to demonstrate the advantages of exploiting the electrorheology effect.

PHASE III DUAL USE APPLICATIONS: There is a tremendous market potential for devices exploiting the advantages of electrorheology. Two of the primary advantages are the elimination of mechanically activated components and almost instantaneous response. The field of robotics, as well as the automotive industry, is keenly interested in developments in this area. Land warfare could also potentially be the beneficiary of advancements, including the stabilization of helicopter platforms, recoil mechanisms, and components for robots of Army interest.
OPERATING AND SUPPORT COST REDUCTION: The use of "smart fluids" could ultimately result in the elimination of some types of mechanical moving parts leading to savings in both cost and weight. Failure of such mechanical parts currently requires expensive spare part stockpiles and equipment downtime. Smart fluids have the potential to replace the need for these parts while allowing the device using these fluids to actually operate faster and more efficient.

A97-135 TITLE: Production of Higher Performance Hydrogen-Absorbing Alloys/Composites for Battery Applications

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop hydrogen-absorbing alloys/composites which provide increased capacity for storage and transportation of energy over current battery systems with extended life and/or reduced detrimental effects on the environment.

DESCRIPTION: Elimination of environmental pollution involves reduction of use of metals such as mercury, cadmium, and cobalt. These have been used in batteries. The current commercial re- chargeable batteries using the Ni-H system can be improved with the use of MmNix, or with a variation whereby the Ni is replaced with a nickel alloy, as the negative electrode. (Mm is a Lanthanide or a mixture of Lanthanide metals and x is a number close to 5). Large hydrogen storage capacity of the negative electrode, lack of corrosion and friability upon multiple charge/discharge cycles, and the ability to maintain discharge capacity after large numbers of cycle are needed. The negative electrode alloy needs to have high hydrogen mobility in the bulk (faster than the surface absorption/desorption rates) and the pertinent equilibrium hydrogen pressure (P-C-T diagram). New alloys and multiphase alloy systems (composites) are sought in battery systems with higher energy density for increased mobility and elimination/reduction of use of elements that are detrimental to our environment.

PHASE I: Identify and develop materials and processing methods for the fabrication and production of sufficient quantities of materials to demonstrate enhanced properties. These materials should show properties that provide advantages for battery applications, such as higher hydrogen absorbing capability or reduced deterioration of discharge capacity over large number of charge/discharge cycles, or reduced corrosion or friability or other properties appropriate for energy storage applications. Materials developed must be adaptable to large scale production. These properties must be demonstrated and materials delivered along with the methodology of production and appropriate test or experimental results that fully demonstrate the advantage of the materials and processes developed.

PHASE II: Phase II work should exploit the success of Phase I and concentrate more on extensive demonstration of overall system enhancement as a battery or energy storage arrangement. Phase II should attempt to apply the materials and processes to making components or prototypes. It should focus on manufacturing issues. It should deliver a prototype or demonstration device which has higher capability or advantage over current commercial capability. An adequate number of experiments or test of the prototype should be conducted to fully demonstrate its enhanced capabilities as well as its weaknesses.

PHASE III DUAL USE APPLICATIONS: The commercial market for these technologies already exists to the extent that demand exists for higher power density, larger number or re-charge cycles, and reduction of environmental pollution from current battery technology in many applications. These include (to mention a few) laptop computers, household electronics, and

a host of lightweight electronic equipment for space and avionics. Storage of hydrogen for combustion in fuel cells and electric automobiles are keys that limit rapid development of this industry. There are also an increasing number of applications requiring electric, pumpless, liquid-free heat pumps, refrigerators, and air conditioners.

OPERATING AND SUPPORT COST REDUCTION: The development of higher performance hydrogen absorbing alloys/composites for battery applications lends itself to operational savings and cost reduction throughout the batteries active life and even after their usefulness has expired. Longer life power materials offer obvious savings while more environmentally friendly materials would provide cost reductions due to easier disposal at the end of their useful life cycle.

A97-136 TITLE: Portable Microwave Nondestructive Evaluation System

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To create a portable microwave nondestructive evaluation (NDE) measurement tool for examining general composite structures. The instrument must be one person portable and small enough to be "hand-held" operable with the capability of performing quick measurements in a field environment. Access to only a single (usually exterior) surface of the structure must be a design consideration. Application of this technology includes both military and civilian vehicle structures as well as other structural applications where fast and efficient determination of operational NDE problems is required.

DESCRIPTION: A portable hand-held microwave NDE instrument capable of performing quick reflection measurements on nonconductive material media is desired. The operation of this instrument must not require the access to both sides of the structure. Initial work will concentrate on developing a prototype version. The system will be comprised of a microwave energy source, scanning equipment, microwave circuitry which includes waveguides and feedhorns, a network analyzer, and voltmeters. Electric field and voltage reflection measurements will be obtained in the frequency domain. The system will produce C- Scan type images giving information about material properties, measure thicknesses of material layers, characterizes flaws, voids and delaminations, and determine porosity and moisture levels. Measurement correlations between moisture contamination and adhesive bond strength between layers will be investigated.

PHASE I: Develop microwave scanning instrumentation for "in laboratory" measurements having the ability to clearly detect benchmark flaws in a composite test panel. The panel will be a six-layered composite structure typical of the Army's Composite Armored Vehicle (CAV), containing six benchmark holes and areas of moisture contamination. Deliver system to Government upon successful completion.

PHASE II: Develop and implement a prototype portable "field" version of microwave instrumentation introduced by Phase I work. This phase will emphasize the replacement of near scanning instrumentation with a hand-held measurement device. The microwave system will be made more compact with microwave energy source, circuitry, network analyzer, and a lap top computer packaged into a single unit.

PHASE III DUAL USE APPLICATIONS: Specific NDE applications include Army ground vehicle and civilian aircraft fuselage examination. General applications include detection of fatigue cracks on metal surfaces, material porosity estimation, and cure monitoring (quality assurance) of chemically produced composites.

OPERATING AND SUPPORT COST REDUCTION: The development of a portable nondestructive evaluation system has the potential to allow military and commercial users to address a two major cost considerations QUALITY and SAFETY. Production and operational life cycle evaluation can be an expensive undertaking. A means to non destructively examine structures for production or use/fatigue flaws could address both of these considerations, with savings measured possibly in dollars and lives.

A97-137 TITLE: Gun Tube Wear and Erosion Prevention

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop materials, processes, and/or equipment necessary to produce gun barrels with wear and erosion characteristics greatly improved over current materials or methods.

DESCRIPTION: The desire to launch projectiles at higher velocities and greater rates of fire often lead to untenable amounts of wear and erosion in the gun barrel. The current methods for prevention of wear and erosion frequently become inadequate if improvements or modifications incorporate hotter propellants, alternate projectile design, or non-traditional methods of projectile launch. In the past, coatings of refractory metals and alloys have met with some success but these may not be entirely suitable in the future, at least as presently practiced. The interior surface of the gun tube is subjected to an extreme environment which requires resistance to: very high temperatures, projectile impact/engraving forces, thermal shock, and gas erosion. Additionally,

characteristics of a satisfactory bore surface include: a low coefficient of thermal expansion, high fracture toughness/impact strength, low Young's modulus, and a high thermal conductivity.

PHASE I: Identify and develop advanced methods for the fabrication and production of gun barrels with enhanced wear and erosion properties. The calibers addressed should be limited to tank and artillery cannons as improvements in these areas will have the greatest impact. The methods developed should be readily adaptable to current systems and production environments. It is possible, although not required, that any solution developed will require variation of properties, composition, and materials from one location to another within the bore. It may also be desirable to minimize or eliminate interfaces in the system. The proposer should demonstrate the appropriateness of the methods and materials for the application(s), deliver demonstration components produced with the materials, techniques, methods or procedures developed, and obtain or develop testing methods that adequately simulate in-bore environments.

PHASE II: Work in Phase II should exploit the Phase I success, expand the range of materials and processes, and begin to apply the methods developed to production-like situations. This work should highlight the generic nature of the developed material, process or method and deliver prototype or demonstration components. If appropriate, a prototype of equipment developed should be delivered. Testing in Phase II should be suitable to demonstrate the benefits of the material or process developed.

PHASE III DUAL USE APPLICATIONS: Developments in gun barrel wear and erosion prevention would seem to have little application in civilian commercial activities, nonetheless, developments will find application in the prevention of wear and erosion in other systems such as oil drilling tubes and in high temperature boilers.

OPERATING AND SUPPORT COST REDUCTION: Although primarily of concern to the military, gun tube wear and erosion prevention could lead to enormous operational savings and cost reduction when thought of in the context of the shear number of effected weapons in today's armed forces. It is also highly likely that successful completion of this project could derive solutions to commercial materials applications as yet not considered.

A97-138 TITLE: Real Time Full Field Acoustic Inspection Sensors

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop acousto-optic sensors for full-field, real time inspection of materials and components.

DESCRIPTION: Ultrasonic testing is a nondestructive test method which is routinely used to evaluate the condition of materials and/or components. Conventional ultrasonic methods are limited in speed as the inspection is performed on a point-by-point basis where a computer- controlled mechanical scanning system is needed to generate an ultrasonic mapping (C-Scan) of the material. Because of the excessive time required to set up a C-Scan system and perform the scan, many small and/or curved structures are inspected manually (A-scan analysis). Manual inspection is a laborious process which requires highly trained operators. The time, cost, and problems inherent to manual inspection, such as fatigue, can adversely impact the quality of inspection. Acoustography is a process of ultrasonic imaging similar to X-ray fluoroscopy. In acoustography, a sound source is utilized to illuminate a test object with a field of sound waves reflected, refracted, and scattered by anomalies in the test piece. The sound waves are converted into a visual image by a detector screen containing a sound-sensitive liquid crystal layer which can be viewed under polarized light.

Advances in acousto-optic sensors technology will form the basis of a new generation of ultrasonic NDE tools.

PHASE I: The Phase I portion of this effort should concentrate on the development of acousto-optic sensors which will be capable of providing a C-scan representation of ultrasonic data in near real time. Sensors should be developed to include different fields of view and frequencies. The different fields of view developed are required to perform inspections for different size components. For example, items to be inspected could range from small tensile specimens (a couple of inches) to the side of an armored vehicle several feet). Also, different frequencies are required in order to meet the inspection needs of different applications. As a rule, higher frequencies provide increased resolution but have a limited depth of penetration. Therefore, lower frequencies are required to inspect highly attenuative and/or thick-sectioned materials (at a cost of lower resolution). Phase I of this effort should develop sensors of varying frequencies to meet the inspection needs of different applications.

PHASE II: The Phase II effort should apply the newly developed sensors to applications which have previously been limited by the lack of sensor development. For example, the newly developed sensor could be used to take "ultrasonic photographs" of specimens under mechanical test. The current evaluation method consists of performing an ultrasonic scan before and after the test. This method does not provide critical information pertaining to the materials condition during the test. The Phase II effort should also concentrate on applying the sensor to automate tedious and labor intensive inspection procedures. For example, a sensor should be developed to inspect thick-sectioned composites. The sensor can then be applied for the rapid inspection of large areas, such as the Composite Armored Vehicle, in near real time.

PHASE III DUAL USE APPLICATIONS: The system will be well suited for a laboratory environment, production lines, as well as in the field. This technology is also expected to result in new medical imaging applications.

OPERATING AND SUPPORT COST REDUCTION: The development of a portable nondestructive evaluation system has the potential to allow military and commercial users to address a two major cost considerations QUALITY and SAFETY. Production and operational life cycle evaluation can be an expensive undertaking. A means to non destructively examine structures for production or use/fatigue flaws could address both of these considerations, with savings measured possibly in dollars and lives.

A97-139 TITLE: Pneumatic Device for the Insertion of Discontinuous Reinforcement Into Dry Fiber Preforms

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: The objective is to develop a pneumatic device (a gun-like device) for the insertion of discontinuous reinforcements made from unidirectional composite material for insertion into dry fiber preforms. Variants of this device could be integrated onto robotic arms or as a hand-held and operated tool.

DESCRIPTION: Economically improving the interlaminar properties of composite materials and structures is one of the keys to broadening its use for military and civilian applications. The Army Research Laboratory's Vehicle Technology Center has modified a conventional pneumatic nail gun to insert nails fabricated from unidirectional composite material for insertion into dry fiber preforms. The composite nails resemble their metallic counterparts in that they are of fixed length and the nail strip contains only a couple hundred nails formed together. The limitations of this prototype nail gun is the use of fixed length nails and finite length (4 to 5 inches) nail strips and a fixed cross-sectional dimension nail. A new device needs to be developed that is applicable to robotic devices as well as hand- operated. Concepts need to be developed to use continuous feed rod material that will allow for tailoring nail length. Alternative concepts using a nail strip cartridge that consists of spooled nail strips several feet in length would also be useful. The nail gun should have multi-nail insertion capability, for example four to ten nails uniformly spaced per insertion cycle, at insertion cycle rates in excess of 1Hz. Potential insertion angles should be from normal to the surface to 45 degrees to the surface.

PHASE I: Develop prototype nail gun with either a continuous composite rod supply or a nail strip cartridge of fixed-length composite nails. Demonstrate rod insertion into carbon and glass dry fiber reforms. Deliver prototype to the Government for evaluation.

PHASE II: Develop production-type units for both robotic and hand-held applications. Demonstrate application on major section of composite structure and evaluate. Deliver units to the Government for evaluation.

PHASE III DUAL USE APPLICATIONS: The entire composite structures market would greatly benefit from a device that inserts discontinuous rods through the thickness of dry fiber preforms. The use of discontinuous rods has been shown to produce significantly superior mechanical properties in composite structures as compared to stitching techniques. This device could reduce the fabrication cost as compared to stitched preforms.

OPERATING AND SUPPORT COST REDUCTION: Faster, cheaper, better ways to process and work composite materials have obvious applications for both military and commercial users.

A97-140 TITLE: Identifier for Individual Biological Particles

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Design, construct, and demonstrate an instrument for rapid identification of individual biological particles collected from air or water.

DESCRIPTION: Rapid methods and instrumentation for identifying individual biological particles in samples containing a large excess of interfering particles would be very useful for monitoring and controlling the spread of diseases of humans, animals, and plants, and could provide a major improvement in the ability to detect the use or production of biological warfare (BW) agents. Because BW agents can be lethal at concentrations that are difficult to detect, especially when mixed with a large excess of background particles, instruments which can rapidly detect and identify a very few (e.g., two) biological particles in a complex mixture are important. In many cases it is not feasible to collect particles from a large enough volume of air or water to obtain the 1000's of biological particles required for identification with existing rapid methods. Because existing rapid identification instruments typically monitor total signals (e.g., fluorescence of antibody-labeled cells) from large numbers of particles in a sample, non-specific binding can cause the signals from target particles to be hidden in the noise; sensitivities are

therefore limited, and large volumes of air or water must be sampled. The goal of this task is to develop a prototype identifier for individual biological particles.

PHASE I: 1) Design a fieldable prototype instrument which can rapidly (e.g., 15 min) and specifically identify individual biological particles (as few as one particle) in complex samples taken from air, water, or blood. It is assumed that antibodies (or other molecules with high affinities for surface proteins of interest), and/or nucleic acid probes are available for the specific particles. The instrument should have the potential of being rugged, lightweight, and relatively inexpensive, features that will make it useful for a variety of applications. 2) Build a prototype of the identifier, and demonstrate feasibility of the approach.

PHASE II: Based on the experience obtained in Phase I, design and construct a fieldable instrument which can rapidly and specifically identify individual biological particles, and which can be combined with an air sampler or water sampler so that it can be deployed for remote, stand-alone, monitoring of biological particles.

PHASE III DUAL USE APPLICATIONS: Airborne biological particles are important causes of diseases of humans (e.g., tuberculosis, influenza), animals, agricultural crops (e.g., smuts and rusts), and forest trees. Bacteria are disseminated in the air for the control of insect pests in large areas. Allergies caused by airborne biological particles are important. Waterborne biological particles (e.g., Giardia, cladosporium) are important causes of diseases of humans and some are feared as potential BW agents. Instruments for rapidly identifying individual biological particles could have major applications in medicine, occupational safety, and environmental protection, in addition to their applications to national defense.

OPERATING AND SUPPORT COST REDUCTION: Instruments for rapidly detecting and identifying a small number of individual biological particles in complex samples collected from air, water, blood, etc., could have major applications in health care, occupational safety, water monitoring, etc., in addition to their applications in detecting military or terrorist biological warfare (BW) attacks, and in monitoring the proliferation of BW agents. The dual-use applications are clear. Such instruments could save many lives. Considering the potential battlefield and terrorist threats of BW agents, the problems in monitoring the production of BW agents, the spread of diseases in hospitals, the workplace, schools, etc., and the spread of disease of crops and trees, the potential cost reduction is very large.

U.S. Army Research Office (ARO)

A97-141 TITLE: Gun Tube Liner Erosion and Wear Protection

KEY TECHNOLOGY AREA Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop a process for cladding, welding or joining a 2 to 3mm thick refractory metal to the interior of a large gun barrel-type cylinder.

DESCRIPTION: New methods for fabricating or depositing high temperature liners/coatings, such as high frequency cladding, explosive welding, or microplasma joining of a clad, powder or liner; thick deposition of a suitable material by Centrifugal Self-propagating High-temperature Synthesis(SHS), Electron Beam Plasma Vapor Deposition (EBPVD), Organo-Metallic chemical vapor deposition (OMCVD), laser ablation, etc. are required for protecting the interior of large caliber guns from erosion and wear. Where required for microstructural control, considerations should be made for post- treatment, including autofrettage or other appropriate strengthening procedures. This solicitation topic seeks the development and demonstration of new or internationally-known methods for depositing or cladding well-bonded refractory metals to a typical heat treated gun steel. The new process would replace chromium electroplating methods that coat the interior of large cylinders at rates approaching 1mm/hour.

PHASE I: Based upon existing research capabilities and/or by licensing appropriate patents, experimentally demonstrate bonding and adhesion of 2 to 3mm thick refractory metal liners, or clads or coatings of materials such as tantalum and molybdenum. Provide an economic analysis of scaleup potential that identifies smoothbore gun tubes as the primary product of interest, with chemical process and nuclear power plants as potential civilian sector applications. Phase I should provide an integration plan for incorporating the results of Phase II in a Army Product Improvement Process (PIP) for tank cannon.

PHASE II: A principal objective of Phase II will be to provide two lined prototype gun tubes for Army firing tests. These should be part of an integration plan for direct technology transfer to the PIP. Cost sharing and venture capital involvement for Phase II and Phase III will provide added incentives for project selection.

PHASE III DUAL USE APPLICATIONS: Provides increased artillery capability for next generation military cannons that will require higher temperature and erosion resistance. Will provide corrosion resistant liners for chemical processes, nuclear power plants, and corrosive waste storage applications.

OPERATING AND SUPPORT COST REDUCTION: The topic area research, if successful, could provide substitutes for chromium electroplating processing of gun tubes. Costs for electroplating waste disposal would be minimized. Additionally it is

expected that reduced life cycle costs will result from the introduction of more refractory erosion resistant coatings. The research has potential for reducing costs of piping in chemical plants.

A97-142 TITLE: Amorphous Metal Alloy Matrix Composites for Structural Applications

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Demonstrate the fabrication of bulk amorphous metal matrix composites suitable for Army and/or civilian applications.

DESCRIPTION: Recent generations of amorphous metal alloys have unusual mechanical properties and improved formability. Such amorphous metals have expanded supercooled liquid regions which allow the use of low cooling rates down to 10 K/s to produce bulk castable amorphous metal alloys. In addition, these alloys have low thermal expansion that can match that of high strength ceramic fibers. Their combination of properties allow fabrication of low residual stress composites. Other amorphous metal matrix composites may be fabricated in-situ via controlled devitridication to achieve primary crystallization of nanocrystalline phases. These materials offer high potential for low-cost, high-toughness composite materials with unique properties useful for industrial and military applications. This solicitation seeks the development and demonstration of new or internationally-known methods for fabricating and finding Army and Industrial applications for either low or high density/tough and strong amorphous metal composite materials.

PHASE I: Based upon existing research knowledge and/or licenses of appropriate patents, experimentally demonstrate composite fabrication for 20 thick samples. Provide preliminary materials characterization data such as yield strength, toughness, and corrosion resistance. Identify a minimum of one industrial/civilian or Army systems application as well as potential industrial commercialization partners. Provide a cost/economic analysis for application and scale-up. Phase I should provide an integration plan for incorporating the results of Phase II in and Army or Civilian application.

PHASE II: A principal objective of Phase II will be to provide prototype components for Army of Civilian sector application. These should be an integral part of the Phase I plan for technology transfer and commercialization. Cost sharing and venture capital involvement for Phase II and III will provide added incentives for project selection.

PHASE III DUAL USE APPLICATIONS: Results of research may provide lightweight, tough and corrosion-resistant composite materials for mobility equipment and improved resiliency for athletic equipment, novel structural components requiring a unique combination of resiliency, corrosion resistance, strength and durability.

OPERATING AND SUPPORT COST REDUCTION: Recent generations of amorphous metal alloys have unusual mechanical properties and improved castability. These materials offer high potential for low cost, high toughness composite materials with unique properties for industrial and military applications. This research, if successful, will identify methods for fabricating either low or high density/tough and strong composite materials. These materials and processes may be used to fabricate repair parts and components less expensively than current methods.

A97-143 TITLE: Sensors and Controls for Advanced Diesel Engines

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/GroundVehicles

OBJECTIVE: To develop and demonstrate one or two sensors and associated control strategies for real-time monitoring, control, and optimization of reciprocating (diesel) engines.

DESCRIPTION: Laboratory research has demonstrated that it is possible to markedly improve diesel engine performance through novel approaches to fuel injection, such as multi-pulse and piloted injection sequences. Such approaches, if combined with real-time engine condition monitoring, offer the potential for dramatic performance improvement, especially at off-design conditions. A major barrier to the implementation of these concepts is the bulk and complexity of sensors and actuators in any control scheme. However, recent advances in Microelectromechanical Systems (MEMS) and hybrid electro-optic sensor technologies may allow development of compact, robust sensors and actuators for diesel engine applications, (for example in fuel and air-flow control, etc.). Innovative concepts are sought which will lead to the development and integration of effective, real-time control systems.

PHASE I: Determine one or two sensors and effective control strategies for engine control and performance optimization. Develop preliminary designs for one or more sensors and actuators. Assess the potential performance enhancements resulting from the application of the proposed systems.

PHASE II: Develop prototypes of selected designs, incorporate into suitable engine. Determine effectiveness of systems and effect on engine performance parameters.

PHASE III DUAL USE APPLICATIONS: These technologies have potential broad application to both military and civilian engines.

OPERATING AND SUPPORT COST REDUCTION: One of the biggest logistics burdens to the modern Army is the appetite of weapons systems for logistics fuels. Laboratory research has demonstrated that it is possible to markedly improve diesel engine performance through novel approaches to fuel injection, such as multi-pulse and piloted injection sequences. Such approaches, if combined with real-time engine condition monitoring, offer the potential for dramatic performance improvement, especially at off-design conditions. A major barrier to the implementation of these concepts is the bulk and complexity of sensors and actuators in any control scheme. Recent advances in Microelectromechanical Systems (MEMS) and hybrid electro-optic sensor technologies indicate that it may be possible to develop compact, roust sensors and actuators for engine application, for example in fuel and air-flow control, etc. This research, if successful, will enable diesel engines to be operated in a more fuel efficient manner.

A97-144 TITLE: Improved Actuators for Smart Structures

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop and demonstrate low-cost high-performance, innovative smart actuators (of physical dimensions of the order of centimeters or less) and their associated driving electronics and control systems for applications, for example, structural damping, noise reduction, precision pointing, or vibration isolation.

DESCRIPTION: In many commercial machines and military systems and vehicles, the relative flexibility of the structure and mechanical elements is one of the main sources of limitations on operational performance. These structural flexibilities lead to vibration and control problems during operation (especially at high operating speeds) even though lightweight and stiff advanced materials such as composites and ceramics may be regularly used in their construction. Much progress has been made in recent years in the utilization of smart materials in actuator design for damping and/or micro- positioning in these systems. However, successful utilization of such actuators will depend on their cost and ease of system integration and retrofitting. This topic solicits proposals for innovative concepts addressing issues in the development of design tools, methodology, modeling, simulation, prototyping, and real-time software/hardware implementation for one or more designs for actuators based on smart materials.

PHASE I: Develop methodology and various designs for dampers and induced strain actuators and associated drive electronics and control systems. In Phase I, concrete designs of one such actuator and their associated drive electronics and control systems is expected. These designs are expected to be scaleable and easily retrofitable for other applications. The performance is to be demonstrated and verified through computer simulations.

PHASE II: Develop a fully integrated design, test, and prototyping environment for development of high bandwidth actuators and their associated drive electronics and control systems. These actuators should be prototyped and fully tested. It is expected that these actuators and their associated driving electronics and control system will be fully developed and designed for being easily manufactured by the end of Phase II. Furthermore, successful applications are to be demonstrated, possibly in helicopter rotor systems or rapid firing weapon systems.

PHASE III DUAL USE APPLICATIONS: Low-cost, high-bandwidth, high authority (force/displacement characteristics) actuators are needed for both military and commercial applications. A number of commercial systems and machinery do require added low cost actuators for performance enhancement. Examples of such commercial systems used in the electronics industry are laser lithography machines, lead-bonding machines, and inspection and probing machines. Additional commercial applications will be found in automated quality control machinery, metrology related machinery, and machinery for the production and testing of ultra-high quality optical components and instruments.

A97-145 TITLE: Multi-Sensor Technologies for Detection of Unexploded Mines

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To investigate technologies for detection of mines.

DESCRIPTION: Humanitarian demining has become in recent years a crucial unsolved problem (e.g. recent peace-keeping efforts in Bosnia). Technologies to greatly improve demining could also have significant commercial overlap as well in areas of toxic waste detection and environmental reclaiming. Most present-day approaches to detect unexploded mines exploit sensing of a single physical property associated with the mines, e.g., a difference in either optical or electric properties, or the presence of a small quantity of metal. A crucial problem not completely addressed by present methods is the elimination of clutter, particularly in situations of humanitarian demining. A multi-sensor approach to detecting unexploded mines will have the advantage that complementary characteristics of various mine detection methods can be combined to minimize clutter; including olfactory sensors and other biological/biometric detectors. With current methods, there has been less focus on technologies that seek to detect the explosive or toxic waste material directly or can detect the low atomic number components of "plastic" mines. Recent advances in X-ray detectors (particularly array detectors) now offer new high levels of sensitivity for backscatter detection of low atomic number mine components. The Federal Aviation Administration has sponsored work in explosives detection, but systems resulting from these efforts are typically geared toward large, fixed operations and do not have the selectivity which can be achieved with a multi-sensor approach. Recent advances in sensors, such as those using surface acoustic wave technology, nuclear quadrupole resonance (NQR), collimated X-ray backscatter techniques, and conducting polymer-based techniques, among several others, may afford new opportunities for the detection of explosives in portable military applications. This topic addresses novel techniques with the potential for applications in a multi-sensor system for detection of explosives or other mine components.

PHASE I: Demonstrate detection of explosives (vapor or condensed phase) and other mine or toxic waste components using at least two complementary sensor methods under laboratory conditions at field-level concentrations in the presence of common environmental interferants.

PHASE II: Using a prototype multi-sensor system, demonstrate detection of explosives under field-conditions and evaluate the probability of detection and false alarm rate.

PHASE III DUAL USE APPLICATIONS: Unexploded land mines remain a large civil and military challenge in many areas of the world. Large market exists for use of such a capability.

OPERATING AND SUPPORT COST REDUCTION: The demilitarization of military target ranges and other DoD properties scheduled to be returned to the commercial sector of the economy could be enhanced by better demining capabilities. This research could lead to a better detection capability for certain unexploded ordnance/mines on target ranges. Safer and more reliable demining operations could lead to a decreased cost of returning these facilities to the private sector.

REFERENCES:
1. J. G. Campbell and A. M. Jacobs, Nuclear Science and Engineering, 110, p. 417 (1992).
2. Marc Nyden, in "A Technical Assessment of Portable Explosives Vapor Detection Devices", NIJ Report, pp. 300-89 (1990).

U.S. Army Aviation Research, Development and Engineering Center (AVRDEC)

A97-146 TITLE: Advanced Materials for Helicopter Propulsion Systems

KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: Develop innovative Gas Turbine and Mechanical Power Transmission materials which would greatly increase the performance of current and future helicopter propulsion system components.

DESCRIPTION: This topic focuses upon the development of advanced materials for use in the turboshaft engines and main gearboxes of the U.S. Army's helicopters.

The first area of interest is the turboshaft engine. In order to reach the performance goals of 120% increase in power-to-weight ratio and 40% reduction in specific fuel consumption, engine rotor speeds and temperatures will be required to increase significantly. Advanced materials which can accommodate these speeds and temperatures and provide high durability and reduced weight are desired. Materials under consideration include Organic Matrix Composites (OMC's) for inlet housings and casings; Titanium based Metal Matrix Composites (MMC's), orthorombic titanium, and super alpha-2 titanium for use in axial and centrifugal compressor rotors; gamma titanium aluminide for use in the compressor diffuser; high temperature materials such

as Ceramic Matrix Composites (CMC's) for use in the combustor liner; and a combination of materials with much greater temperature capability such as fourth generation single crystal alloys, intermetallics and insitu monolithic ceramics for use in the gas generator and power turbine stages. The application of these advanced materials will necessitate more than a material substitution to take full benefit of the materials. For example, concepts involving replacing disks by rings, utilizing a dual microstructure in the disk, or dual alloy components are currently being pursued. Thus, innovative structural concepts, design methodologies, and the strong desire for an affordable manufacturing process should be seriously considered.

The second area of interest is the helicopter main reduction gearbox. The Army's goals of 25% increase in power-to-weight, 2X increase in reliability and -10db noise generation for the transmission must be achieved without compromising operational requirements. Because they operate in close proximity to the ground, helicopters are susceptible to small arms fire. The ability to tolerate small arms fire is a major concern for helicopter drive trains. The transmission is required to operate for 30 minutes after loss of the primary oil supply (due to battle damage). In current rotorcraft this is achieved by the use of an emergency air/oil mist systems or a compromise in the designs weight and durability. In order to avoid weight, durability, reliability, and maintainability issues associated with current approaches, the U.S. Army is interested in the development of advanced materials, and their associated fabrication methods, which would reduce the friction and heat generation created in the surface contact regions of the gears. Also of interest are approaches that utilize advanced materials in configurations that allow the heat to be transferred away from the gear teeth during periods of loss of lubrication operation. If successful, this technology could result in significant improvements in rotorcraft gearbox weight, volume, cost, increased reliability, and much greater survivability. The tail rotor drive shafts in the Comanche helicopter are located in close proximity to high temperature exhaust ducts. The shafts are made from composite material to provide weight savings. However, shielding is currently needed to provide protection against exhaust duct leaks from cracks or ballistic damage. The development of high temperature, lightweight composite materials and/or thermal protection against exhaust duct leaks from cracks or ballistic damage. The development of high temperature, lightweight composite materials and/or thermal protection coatings for the shafting would allow for elimination of the shielding resulting in a lighter weight system. The Army desires light weight shaft material capable of operation up to 600□ F continuous with short term capability to 1200□ F. The material should allow the shafts to be designed with the same rotordynamics characteristics of the current shafting.

PHASE I: Proposed efforts should define the operational requirements of the application for which the material/material system is to be applied. This should be done with the assistance of either a turboshaft engine or helicopter manufacturer as a consultant. Effort should be conducted to evaluate the feasibility of the manufacturing process necessary to utilize the proposed material/material system in the selected component. The critical processing steps should be identified and preliminary bench type testing of the critical steps should be conducted. These tests should be sufficient to evaluate the potential of the proposed material/material system for further development.

PHASE II: Efforts in Phase II shall be focused upon the fabrication of a full scale component which can be tested in either a current or advanced development gas turbine engine or rotorcraft main reduction gearbox. A turboshaft engine or helicopter manufacturer should be involved in the development and evaluation of the proposed approach. The proposed effort should address the development of a complete manufacturing process for the subject material/material system.

PHASE III DUAL USE APPLICATIONS: The technologies used in the propulsion systems of helicopters are common to just about all forms of aerospace propulsion systems. This is especially true for turboprop type commuter aircraft which historically have utilized military engines as the basis for the development of new commercial products. The gears and bearings to be developed here will be directly applicable to the propeller gearbox of the commuter aircraft as well as the many other locations where lightweight highly durable gears and bearings are used. Thus the potential commercial market is quite large for the application of the advanced materials which would result from the materials developed from this topic.

OPERATING AND SUPPORT COST REDUCTION: To develop innovative gas turbine engine and mechanical power transmission component technologies which will provide Army rotorcraft with engines having increased power-to-weight ratios and reduced specific fuel consumption and drive trains that are lightweight, have lower levels of noise generation and have improved durability. Furthermore, a reduction of specific fuel consumption and increased component durability and life will address the Operation & Support Cost Reduction (OSCR) for future Army helicopter propulsion systems.

A97-147 TITLE: Turboshaft Engine and Rotorcraft Drive System Technology

KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: To develop innovative gas turbine engine and mechanical power transmission component technologies which will provide future Army rotorcraft with engines having increased power-to-weight power-to- weight ratios and reduced specific fuel consumption and drive trains that are lightweight, have lower levels of noise general component durability. Furthermore, a reduction of specific fuel consumption and increased component durability and life will address Operating and Support Cost Reduction initiatives.

DESCRIPTION: The general path to increasing propulsion system capabilities includes, but is not limited to, higher maximum temperatures to increase the output per unit airflow; less weight per unit airflow is required to increase the output per unit weight; and increased component efficiencies for decreased specific fuel consumption while maintaining or increasing component durability and life and maintaining or decreasing cost per unit output. To achieve the necessary future propulsion technology advances, technology strides in the compression systems; combustion systems; turbine systems; controls and accessories; and mechanical systems of a gas turbine engine are required. Specific propulsion technology development areas include high pressure ratio, lightweight compressors; combustors that are lightweight with reduced pattern factors and higher inlet and outlet temperatures; lightweight turbines with increased temperature capability, reduced cooling air requirements, and high work extraction; advanced materials/materials systems and innovative structural concepts to accommodate the stresses developed at the required higher speeds and operating temperatures. Thus, future propulsion systems necessitate further developments in aerothermodynamic design capability for improved component efficiency level and improved control of heat transfer; and further developments in mechanical designs for application of higher temperature, lightweight materials in conjunction with innovative structural concepts to maintain life and durability. These engines produce high speed/low torque shaft power output.

Rotorcraft utilize reduction gearboxes and shafting to transmit and convert the high speed low torque engine output to the low speed/high torque conditions required by the aircraft's main rotor. These transmissions must achieve very high reduction ratios with minimum weight, parts count, and volume. They must have efficiencies greater than 99.5% and the ability to operate without oil for 30 minutes. Innovative concepts which can reduce the weight, lower the noise, and increase the reliability of these reduction gearboxes are desired. This could be accomplished with innovative configurations of conventional gearing or new and innovative speed reduction devices. The major helicopter producers appear to be moving towards gearbox configurations which split the input torque into multiple paths and recombine it in a final large drive gear. Maintaining close to 50% power in each of the paths is critical to maximizing the advantages of this approach. Jackshafts (two spur or helical gears connected by a common shaft) are typically used in these configurations. Innovative static-load torque dividing devices based upon solid state elastic deformation or zero-torsional stiffness mechanisms with limited motion are desired for increasing is torsional compliance of the connecting shaft. This compliance is necessary to accommodate the manufacturing inaccuracies in the gears which can cause poor load sharing. Very high precision/cost manufacturing methods are currently utilized. Other component areas of interest include lightweight ballistically tolerant shaft/coupling concepts, and overrunning clutches which can operate at engine output speeds.

PHASE I: Define a novel concept or innovative technology which is potentially applicable to future turboshaft engines or rotorcraft drive systems. Based on the technology to be pursued, devise a methodology which addresses and substantiates the feasibility of the proposed approach. Define the potential benefits achievable through the application of the proposed concept/technology.

PHASE II: Pursue further the technology defined in the Phase I effort. Fabrication and component or subcomponent testing should be performed to substantiate the technology and its intended end application. The technology should be suitable for transition into a turboshaft engine or rotorcraft drive system.

PHASE III DUAL USE APPLICATIONS: Aircraft gas turbine engine and drive system technology is vital to the US industry base. Gas turbine engine and rotorcraft drive system is applicable to both the military and commercial markets. Potential technologies resulting from this effort would provide significant benefits to future rotorcraft and ensure US preeminence in the increasingly competitive international marketplace.

U.S. Army Communications and Electronics Command (CECOM)

A97-148 TITLE: Advanced High-Energy Polymer Electrolyte Batteries

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: To develop safe high-energy rechargeable battery chemistries with low-temperature operating capability, designed for compatibility with continuous manufacturing processes based on laminate packaging technology.

DESCRIPTION: The Army must reduce life-cycle costs of batteries used in its portable electronic equipment. This will place more emphasis on the use of rechargeable batteries for use in training as well as combat scenarios. Current rechargeable battery chemistries in the Army inventory include NiCd and NiMH which provide energy densities of approximately 16 Wh/lb and 22 Wh/lb, respectively. The newest chemistry to enter the inventory is Li-ion, with a liquid electrolyte, which will provide 46 Wh/lb in a battery with small cylindrical cells. User safety and low-temperature operation are still areas of concern in batteries with larger cells containing liquid electrolytes. New gel or solid polymer electrolytes that will improve safety, provide lower flammability, increase low-temperature performance, power density, and storability are needed. Other solutions may be found in the areas of improved anodes, greater capacity Li insertion cathodes, and improved separator materials.

PHASE I: Identify and investigate anode, cathode, and electrolyte materials for improved Li or Li-ion polymer batteries. Develop electrode fabrication techniques and identify associated laminate cell package designs. Key areas are electrolyte evaluation for low-temperature operation and the potential for low-cost commercialization of the battery chemistry and technology.

PHASE II: Fabricate and demonstrate energy density, safety aspects, and cycle life capability in prototype polymer electrolyte, laminated cells, and multicell battery configurations.

PHASE III DUAL USE APPLICATIONS: Safe high-energy rechargeable battery chemistries that can be easily manufactured in various light weight multi-dimensional configurations at a low cost are being investigated for a wide range of portable electronic products such as cellular phones, computers, and camcorders.

OPERATING AND SUPPORT COST REDUCTION: Rechargeable batteries that can be reused 300 to 500 times will significantly reduce training costs. Improved rechargeable batteries based on Li-ion polymer technology will increase battery and equipment operation time by greater than 50% over current rechargeable chemistries, NiCd and NiMH.

A97-149 TITLE: The Development of Generic Spatial Reasoning Modules to Support the Construction of Robust, Context-Sensitive Data Fusion Algorithms

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To provide data fusion algorithm developers with enhanced spatial reasoning support that facilitates the development of more robust and context-sensitive data fusion algorithms. To achieve this objective, a comprehensive set of generic spatial reasoning modules will be defined. A selected set of these modules will be developed. These modules should extend the support already provided by current commercial capabilities such as Geographic Information Systems and Relational Database Management Systems.

DESCRIPTION: Effective data fusion algorithms must be robust, context- sensitive, and efficient. For many Army-domain applications, terrain reasoning underlies such a capability. Spatially-distributed domain features, such as terrain, vegetation, soil type, water features, weather, and a wide variety of cultural features can impose problem- solving constraints that must be utilized to achieve effective algorithm performance. The lack of adequate spatial reasoning support represents a critical bottleneck to sophisticated data fusion algorithm development. Thus, spatial reasoning represents a critical enabling technology.

In recent years, there has been a significant increase in commercial support for spatial reasoning. Modern Geographic Information Systems (GIS) support spatial search, Boolean set operations, and proximity- based queries. Specialized terrain analysis and terrain reasoning tools, such as the Army's Terrain Evaluation Module (TEM), have been developed that generate terrain analysis products that can be used by context-sensitive data fusion algorithms.

However, despite considerable progress, there remain significant shortcomings in spatial reasoning support. For example, most existing capabilities support only highly local, single level-of-abstraction spatial reasoning (e.g., the determination that a particular vehicle is currently "on" or "off" the road network).

On the other hand, the goal of achieving both global solutions and efficient algorithm performance can lead to the requirement for multiple level-of-abstraction spatial reasoning support. For example, a global approach to target tracking might require the

evaluation of target track extensions with respect to local criteria (road association, high mobility soil conditions), somewhat more global criteria (road-following, minimum terrain gradient following), as well as highly global criteria (minimum travel distance, destination determination).

The initial goal of this effort is to identify significant shortcomings of current support to spatial reasoning and opportunities for building generic, reusable spatial reasoning functionalities that will overcome those shortcomings. This effort should enhance the current terrain reasoning infrastructure by developing top-down, multiple level-of-abstraction functionalities that permit the exploitation of multiple resolution spatial search, complex query, and data manipulation operations. Two critical design parameters in this work are (1) algorithm computational efficiency, and (2) database operation efficiency. In addition to deterministic terrain reasoning support, this effort should explore opportunities for incorporating fuzzy-based spatial reasoning into future commercial database or GIS products.

PHASE I: In Phase 1, the state-of-the-art in commercially available terrain reasoning products will be reviewed and evaluated. A taxonomy of required spatial reasoning capability should be developed to help identify critical shortcomings of existing commercial products. This analysis should consider the support provided to both intuitive algorithm development and efficient algorithm performance. A selected set of these generic functional modules should be identified for the purpose of developing a detailed functional design. A representative set of context-sensitive data fusion algorithms that would benefit from the development of the selected spatial reasoning modules must be identified.

PHASE II: In Phase II, the modules that were designed in Phase I will be implemented in C Programming Language, tested, and evaluated in at least one comprehensive application. The benefits, in terms of algorithm robustness and algorithm efficiency enhancements over more conventional approaches, should be demonstrated.

PHASE III DUAL USE APPLICATIONS: Earth resource, mapping, law enforcement, land use, and treaty verification activities could all benefit from the availability of powerful automated tools to support a wide range spatial reasoning functions.

OPERATING AND SUPPORT COST REDUCTION: The objective of this topic is to develop generic spatial reasoning capability that complements existing commercial software products. The overall goal of the effort could be to avoid the cost of continual redevelopment of such functionality by individual users. Since spatial reasoning underlies a wide range of DoD and commercial applications, such a capability would significantly improve infrastructure support to general machine based reasoning. By developing the capability as a database shell, large scale reuse is virtually guaranteed, leading to significant cost savings.

A97-150 TITLE: Tactical, Multifuel, Man-Portable Battery Charger

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: To provide a man-portable, multifuel, silent energy source for forward area Battery Charging.

DESCRIPTION: With the deployment of new rechargeable batteries, the Army must update its power source technology to provide man-portable, tactical, silent battery chargers for forward area applications.

Continual replacement of non-rechargeable batteries is costly and is becoming a serious logistic problem. For example, multiple primary batteries could be replaced with a single rechargeable battery of the same form and fit. For forward area recharging capability, military personnel must be provided with lightweight battery chargers operating on logistically-available liquid fuel.

Modern warfare requires that the dismounted soldier carry multiple batteries for communication and night vision equipment and for projected use of climate-controlled suits and global positioning systems. It would be advantageous to be able to replace multiple primary batteries with a single rechargeable battery and then equip the dismounted soldier with a small, lightweight, fuel-fired recharging unit. Since hydrocarbon-fuels have a very high energy density, (approximately 100 times greater than present batteries), the result would be a net decrease in weight and life-cycle cost. A thermophotovoltaic (TPV) power source is a direct energy conversion device that uses photovoltaic cells to convert radiant energy from a ceramic element heated by burning a hydrocarbon fuel such as butane or JP-8. Such a TPV power source can be engineered as a portable battery charger with different power levels (from few watts to few hundreds watts) to meet two basic power source requirements; a) a single dismounted soldier, where a battery recharge TPV unit could be collapsed into the same volume as a single battery, and b) recharging of several larger batteries with a lightweight, silent, multifuel (logistically available hydrocarbons) TPV unit, of 200-300 watt power output to provide forward area battery recharging in close proximity of the user equipment.

PHASE I: Utilizing state-of-the-art TPV components, design and fabricate a 10-20 watt, propane/butane-fueled TPV power source unit to demonstrate viability and usefulness as a TPV battery charger.

PHASE II: Design, fabricate, and test multifuel (using logistically available hydrocarbons such as, JP-4 and JP-8) TPV battery charger prototypes in both 20- and 200-watt power configurations to demonstrate field operation and supportability.

PHASE III DUAL USE APPLICATIONS: Development efforts are underway in the private sector, both in the United States and in Europe, to produce and market portable TPV power sources to generate electricity for residential and recreational vehicle (RV) use. However, all private sector efforts are directed for the use of gaseous hydrocarbons (propane, butane, etc.) to fuel the TPV generator. For military use a TPV power source must be capable of operating on liquid hydrocarbon (diesel) available in the field, and the development of a specific liquid burner-TPV power sources is necessary. Commonality of other TPV system components (PV cells, emitter, etc.) with products made for the commercial market will significantly reduce the cost of a TPV Battery Charger developed for military use.

OPERATING AND SUPPORT COST REDUCTION: The replacement of a throwaway battery with a rechargeable one of same chemistry and size will drastically reduce the number of throwaway batteries procured annually. For example, a Lithium rechargeable battery can be recharged and reused up to 200 times replacing the 200 Lithium Sulfur Dioxide BA 5590 throwaway batteries which are procured at a cost of approximately $60 each. The drastic reduction in the number batteries procured annually will significantly reduce the O&S cost of the battery operated equipment and will also strongly impact on the used batteries disposal cost and reduce environmental pollution.

U.S. Army Edgewood Research, Development and Engineering Center (ERDEC)

A97-151 TITLE: Biologically-Generated Multi-Spectral Obscurants

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Develop a biodegradable (i.e., non-persistent), nontoxic, multi-spectral obscurant from biological materials.

DESCRIPTION: Smokes and obscurant materials are used to defeat enemy sensors on the battlefield. The ideal obscurant should have multi- spectral capability (defeating enemy sensors across the visible infrared, near IR, and radar spectra for example), should be non- persistent and biodegradable, and should be nontoxic to humans. The focus of this topic is to develop smoke/obscurant materials that will be rapidly dissipated in the environment yet maintain the same spectral signature obscuration properties required of current materials.

PHASE I: Show multi-spectral obscurant capability of biodegradable, nontoxic, non-persistent, obscurant materials. Establish basic parameters for biomanufacturing process.

PHASE II: Develop manufacturing process appropriate for large- scale production. Demonstrate retention of multi-spectral properties upon dissemination. Assess mammalian pulmonary toxicity of materials.

PHASE III DUAL USE APPLICATIONS: Production processes for large-scale manufacture of biological materials which minimize production of waste by-products would be applicable to many biomanufacturing processes, especially those for industrial enzymes.

OPERATING AND SUPPORT COST REDUCTION: Biologically based obscurants should result in significant cost savings in three ways. First, production of biological materials can be accomplished using standard industrial scale fermentation and the materials are cheaper to produce than existing obscurant materials. The basic commodity is polylactic acid, which is manufactured in bulk for other applications. Second, savings will be realized in the clean-up required after training exercises in the field. These materials are biodegradeable and can be left to biodegrade to harmless by-products without expensive remediation. Third, the materials are non-toxic and will pose a far smaller health hazard than existing obscurants.

A97-152 TITLE: Optimization and Modeling of Genetic and Bioreactor Parameters of Recombinant Protein Products

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: To develop a mathematical model of cellular metabolism in order to optimize bioreactor feeding regimens, minimize product degradation, and increase yield and decrease costs of valuable recombinant proteins.

DESCRIPTION: Recombinant DNA technology allows foreign genes to be expressed in bacterial, fungal, insect, and mammalian systems. Cells can be genetically engineered to produce large amounts of foreign protein; recombinant protein produced may be as much as 50 percent of total cellular protein. In addition to the protein of choice, unwanted proteins may be produced which can be eliminated by proper construct choices and purification protocols. The induction of high- level expression of foreign protein can elicit a stress response by exhausting the cellular pools of precursors. Action of these stress responses decreases product yields. Models to optimize bioprocess variables, including both genetic and bioreactor parameters, have not been developed, resulting in non-optimum yield of value-added recombinant products. Modeling of biological systems can be a cost- effective tool for control.

PHASE I: Assess protein turnover rates for model protein expression systems. Adapt a detailed metabolic model to include protein turnover brought about by metabolic stress, and cellular and bioreactor parameters.

PHASE II: Incorporate these data into the metabolic model and use it to evaluate and optimize possible nutrient supplementation strategies, bioreactor parameters, and genetic variables. Implement the supplementation strategies and compare actual yields to model predictions.

PHASE III DUAL USE APPLICATIONS: Any production process for large- scale manufacture of recombinant proteins (e.g., vaccines, enzymes, pharmaceuticals).

OPERATING AND SUPPORT COST REDUCTION: Recombinant proteins can be manufactured by standard fermentation using insect, bacterial and fungal cell culture. This approach is far cheaper (an order of magnitude) than production of these proteins using current mammaliam cell techniques. Savings will also accrue from the more rapid selection of cell clones producing a desired material; selection using recombinant technology can be performed in days, whereas selection using standard hybridoma techniques takes months, resulting in greatly increased labor costs for the latter approach.

A97-153 TITLE: Hand-held Biological and Chemical Detector

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Develop a compact lidar device which is tunable from 2 - 10 micrometers for hand-held, stand-off detection of biological and chemical agents and monitoring of environmental pollutants.

DESCRIPTION: Recent modeling indicates that as little as 5 mJ of solid-state laser pulse energy would meet the required detection sensitivity criteria established for the Army's M21 Remote Sensing Chemical Agent Alarm at ranges of several kilometers. This result, coupled with recent advances in solid-state laser and frequency conversion technologies, allows for extremely compact, tunable lasers and lidars to be produced which would be suitable for a hand-held stand-off detection device. In fact, a compact (12" long), lightweight (8 pounds), 1 micron laser source is now commercially available which would be more than adequate as a basis (pump) for such a device.

PHASE I: Laboratory demonstration of a widely tunable (2 - 10 microns), efficient (2% energy conversion from 1 to 10 microns), solid-state laser with pulse energies of 5 mJ and pulse repetition rate of 10 Hz continuous (goal of 50 Hz in a burst mode with at least 20% duty cycle). Conduct feasibility study of a hardened device to recommend a rapid tuning (50 Hz pulse-to- pulse) technique for burst-mode operation, and to investigate potential thermal effects of burst-mode operation.

PHASE II: Extend pulse repetition rate to 50 Hz burst-mode, as described in Phase I, and implement rapid tuning. Produce a fully engineered, hand-held (max. 0.5 cubic foot volume and 20 lbs or less weight) device capable of detecting biological and chemical agents and monitoring environmental pollutants at stand- off ranges up to several kilometers. Verify performance with limited field testing.

PHASE III DUAL USE APPLICATIONS: Handheld, standoff environmental pollution monitoring.

OPERATING AND SUPPORT COST REDUCTION: The automatic Handheld Chemical and Biological (CB) Detector will be smaller and will have a faster response time than devices currently used for CB agent detection both on the battlefield and to determine whether decontamination measures are required. The automatic feature of the Handheld CB Detector will reduce the amount of training required to operate a CB Detector and eliminate O&S costs associated with duplication of efforts due to operator error or misinterpretation of results. The smaller size of the Handheld CB Detector will allow for a man-portable device, reducing transportation and fuel/lubricant costs as well as reducing the manpower and time required for inspections.

Also, the smaller size will inherently reduce the repair facility space, manpower, quantity and size of spare/repair parts, and training requirements. The faster response time of the Handheld CB Detector will give instantaneous results regarding the presence of CB agents which will reduce O&S and manpower costs associated with waiting for minutes or hours for delayed results. The availability of instantaneous results will also reduce the manpower and time required to perform inspections of potentially contaminated areas or materiel. For example, the Handheld CB Detector could inspect 100 or more items of potentially contaminated materiel in the time it takes current devices to inspect one item.

U.S. Army Missile Command (MICOM)

A97-154 TITLE: Polarization Coupling Analyzer for Interferometric Fiber Optic Gyroscope (IFOG) Sensor Coils

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: To develop a user-friendly instrument, based on scanning white light inteferometry, to measure parasitic polarization couplings in a fiber sensor coil wound with 1 km or less of optical fiber.

DESCRIPTION: The ability to characterize IFOG sensor coils wound with long lengths of fiber (at least 1 km in fiber length) is required. In such applications, it is very important to measure spurious polarization cross-couplings in the fiber sensor coil since these can directly affect the performance of the IFOG. This polarization coupling analyzer should also be capable of determining polarization extinction ratio and beat length. This interferometric analyzer would require a translation stage with a large scanning range (250-300 mm) in order to analyze long lengths of fiber (1 km). The instrument should be able to measure continuously the polarization coupling along a coil of fiber with high spatial resolution.

PHASE I: Develop a system concept for the scanning interferometer. This includes designing the optical/electronic hardware portion of the scanning interferometer and develop a Fourier analysis method and appropriate software to convert intensity data to the spatial frequency domain.

PHASE II: Build and test the apparatus designed in Phase I and verify the performance of the scanning interferometer with representative IFOG fiber sensor coils.

PHASE III DUAL USE APPLICATIONS: The commercial and military markets for IFOG systems are emerging. IFOG technology is currently being implemented as part of the navigation/mapping devices installed in luxury Japanese cars and has been implemented into an AF missile system. Other commercial uses, such as intrusion sensors, rate sensors, and platform stabilizers have appeared in the past several years. Since there are numerous applications for IFOGs, especially in navigation and alignment systems, many such systems would benefit from the technology developed under this topic.

OPERATING AND SUPPORT COST REDUCTION: Breakthrough in the Interferometric Fiber Optic Gyroscope (IFOG) technology is allowing insertion into many military applications. For example, the IFOG is being tested as a feedback sensor for a rate stabilization control system in a missile seeker technology demonstration and for helicopter rotors stabilization. Currently, Ring Laser Gyroscopes (RLGs) dominate the market for inertial navigation grade devices and mechanical rate gyroscopes or multisensors are utilized for tactical grade devices. Advancements in which allow for degradation in the IFOG's performance, will speed the replacement of mechanical rate sensors and RLGs.

A critical O&S issue is repair costs over the lifetime of the hardware, the FOG has no mechanical parts, no gas leakage, and low power consumption in comparison with the mechanical sensors and RLGs. The FOGs which are solid-state devices have lifetimes that are not size dependent and are predicted to last over the 100,000 hour category. Small RLGs have very limited operating lifetimes (several hundred hours). Another issue involves low leak rates, which are insignificant for large RLGs, but causes serious shelf-life problems for the small units. As the mechanical rate sensors, which can be found in military land-roving vehicles and in platforms stabilizers, the O&S cost reduction is significant due to savings in maintenance and spare parts.

A97-155 TITLE: Passive Moving Target Indication (MTI) and Tracking of Point and Sub-resolved Targets

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: The Army Missile Command's Research, Development, and Engineering Center has pursued the development of several algorithms for passive moving target indication (MTI) from a moving platform (i.e. missile system target acquisition platform and missile seeker). Two current prototype implementations, however, do not work well if at all in some scenarios with sub-resolved and point targets. The objective of this effort is to first assess current capabilities in this technology area and to adapt the most promising approach, or develop a new approach that will successfully allow the detection and tracking of stealthy sub-resolved and/or point targets

DESCRIPTION: The contractor shall evaluate the current state-of-the- art of algorithms used for sub-resolved and point MTI and/or tracking from a moving sensor. This evaluation shall quantitatively access the capability of each approach as to its probability of detection and false alarm rate. In addition the computational requirements for each of the approaches shall be quantified. The Government shall provide several digital and/or analog data sets, but the contractor shall also select other sequences that might illustrate the limitations and capabilities of the algorithms accessed.

PHASE I: Evaluate current relevant methods. Itemize limitations and provide modifications or new methodology that will allow detection and tracking of multiple targets in air-to-ground, ground-to-air, and ground-to-ground scenarios.

PHASE II: Implement, in real-time hardware, the best method selected in Phase I, using an infrared camera equivalent or the same as those currently used in missile seekers.

PHASE III DUAL USE APPLICATIONS: There are significant potential commercial uses for the technology developed under this SBIR scope of work title. Some of the commercial uses are surveillance, robotics, advanced sensors development, and automated assembly line parts inspection.

OPERATING AND SUPPORT COST REDUCTION: The support cost reduction that would be reflected in the implementation of this topic technology insertion into both the missile system fire control and the weapon itself is indirect but significant. The weapon platform survivability would be significantly improved both from the enhanced ability to detect and track threats at longer ranges than would be normally possible and from the performance increase from the weapon itself.

A97-156 TITLE: Production Techniques for Thin Film Thermal Battery Manufacturing

KEY TECHNOLOGY AREA: Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: To develop production techniques for the manufacture of thermal batteries based upon thin film technology (i.e., slurry method) rather than the industry standard pressed-powder technique to assist in meeting future missile power requirements and thereby enhance the National Technology and Industrial Base.

DESCRIPTION: Significant advances in power and energy density capabilities of thermal batteries will be required for future military applications. It is unlikely that a new thermal battery anode material will be found with electrochemical properties superior to lithium and its alloys. Thermal batteries utilizing lithium/lithium alloy chemistry are used in most MICOM missile applications at this time. More power (energy density) via an increased number of pressed- powder anode pellets is not a viable solution due to size and weight constraints. Thus, different thermal battery production techniques with the potential to increase power, without a corresponding increase in size should be investigated. In recent years the slurry method of thermal battery pellet production has been revitalized and used to successfully build a prototype thermal battery for a next-generation Navy application. This effort was accomplished in an R&D setting rather than a production environment. The current domestic production sole source for thermal batteries appears to be fully committed to the standard pressed-powder technique for thermal battery production. It is not anticipated that an effort to develop thin film thermal battery production techniques will originate in that quarter. Efforts to transition laboratory-scale thin film thermal battery techniques to production need to be pursued. Thin film thermal batteries offer many potential advantages over the current pressed-powder configurations. For instance, given the weight and envelope constraints that thermal batteries in existing missiles must meet, thin film batteries offer the potential to meet enhanced mission profiles (i.e., increased flight times, more powerful seekers, etc.). In this regard, thin film batteries offer the potential to provide an increased power source to support P3I or major modifications to existing systems to meet identified threats in light of the current era of fewer new program starts. Thin film batteries offer the potential for increased shelf life. Pressed-powder pellets are susceptible to degradation due to chemical composition. Thin film production techniques could also minimize pellet loss due to breakage during battery cell assembly. Thin film thermal batteries offer a potential alternative to the existing domestic sole source and the existing European sources. Thin film thermal battery production techniques offer a promising enabling technological solution to sole source concerns.

PHASE I: Examine and define materials and processes required to design and fabricate thin film thermal batteries for a production manufacturing environment. Investigate facility requirements to manufacture thin film batteries, to include facility

layout and production tooling. As a result of the production tooling identification, identify any future needed hardware development efforts. Identify environmental requirements (i.e., dry room, etc.) along with any potential environmental hazards. Define benefits the Government can reasonably expect to see with thin film thermal batteries (i.e., decreased size and weight, improved safety and performance, etc.).

PHASE II: Design and fabricate prototype thermal batteries to meet selected performance requirements and note any reduction in weight/size. Demonstrate capability and verify increased power output profile. It is envisioned that an existing missile battery would be selected, with PMO approval, and the prototype would be built to form and fit specifications and then tested to ascertain increased power output - if any. If successful, thin film technology would offer a way to increase power within the existing envelope.

PHASE III DUAL USE APPLICATIONS: Thermal batteries are traditionally procured by the prime contractor for missile configurations, although re-certification/validation batteries are sometimes procured by the MICOM. However, once established and proven, a thin film thermal battery producer would offer a second domestic source thus expanding the thermal battery sector of the National Technology and Industrial Base. Commercial potential for thermal batteries does exist (i.e., commercial airline safety system deployment, emergency power devices for the automotive industry, etc.) but the labor intensive pressed powder technique currently used has proven to be a deterrent to commercial market development.

OPERATING AND SUPPORT COST REDUCTION: The U.S. Army Missile Command utilizes thermal batteries primarily in missile configurations although there are at least two systems which utilize them in "ground support" equipment. The potential for an increased shelf life of thin film thermal batteries (once demonstrated), could significantly reduce future O&S costs associated with both retrofits (i.e. like the one currently goring on for the STINGER which was partially predicated by battery shelf life and the appropriate ground support equipment (i.e. Javelin, CLM, STINGER BCU - longer operation time equals fewer needed).

A97-157 TITLE: Design and Development of a Microcircuit Epoxy Molding Compound (EMC) Environmental Evaluation Chamber (EEC)

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Design, develop, and fabricate an environmental test chamber containing the capability to simulate and evaluate single event or simultaneously applied multiple stress environments that a plastic encapsulated microcircuit (PEM) encounters during long-term dormant storage in harsh environments. The presently approved PEM accelerated test methods used by suppliers and industry do not provide the simultaneous package and material stresses encountered during long- term storage in harsh environments. An intensive search for long-term dormant storage in harsh environment data has provided negative results. This intensive data search has been conducted by many Department of Defense agencies, IC suppliers, government contractors, and the electronic manufacturing industry. There are no reliability data available to assist in risk decision making when proposing the use of PEM in electronic hardware that will be subjected to long-term dormant storage in harsh environments. An extensive search for a chamber, or chamber concepts, that could be used to conduct the required tests also provided negative results. The result is that the chamber concepts and design will be developed in Phase I. The chamber must then be fabricated. The PEM test requirements pertinent to the reliability degradation of epoxy molding compounds in hazardous storage environments will be validated in Phase II.

DESCRIPTION: The description and required capabilities for the proposed Microcircuit Epoxy Molding Compound (EMC) Environmental Evaluation Chamber (EEC) are provided based on the potential environments that the PEM may encounter during long-term dormant storage in harsh environments. Evaluation of these capabilities indicates why this chamber is presently not available. The performance requirements for the EMC EEC are listed as follows:

1. Temperature cycling range: -65□C to + 200□C. Minimum rate of temperature change is 5□C per minute.
2. Relative humidity (RH) cycling range: 2% to 98%. RH shall be controlled within 2% of required set point.
3. Electrical stimulus application: Capable of bias and non-bias conditions.
4. Electrical testing capability: Test device electrical parameters for any given internal chamber condition.
5. Chemistry stress related environments:
    a. Capability to introduce controlled quantities of corrosive related contaminants ranging from parts per billion (ppb) to parts per million (ppm).
    b. Capability to withdraw samples of gaseous or liquified contaminants at any test phase without impacting the test cycle.
6. Natural environments: Capability and ports to introduce hazardous contributing single or combinations of environments such as: wind speed, talcum grain sand (blowing dust), solar radiation effects, salt fog, free air contaminants, manufacturing process contaminants, and etc.

7. Chamber cleaning requirement: Chamber must be made from materials that will not degrade due to numerous required cleaning cycles and the injection of ionic contaminants.
8. Chamber must contain the capability for the ease of installation and removal of shelves, test sockets and test parts.
9. Chamber volume: The internal volume (working area) should be approximately one cubic foot. The door must seal to meet reduced pressure test requirements.
10. Reduced barometric pressure capability: MIL-STD-883, Method 1001, condition E, 0.315 inches of mercury or 8mm of mercury (equivalent to a height of approximately 100,000 feet).
11. Chamber must be portable and fit on a standard 3 foot wide by 6 foot long bench top.
12. Chamber and accessories must operate from standard 120 Volt, 60 Hz power outlets.
13. Chamber must have the capability for the continuous control and monitoring of applied conditions.

PHASE I: Chamber design and material concepts will be investigated versus the above total chamber operating requirements. Potential chamber materials will be evaluated for durability to ionic contaminants, structural durability, ease and purity of cleaning, ease of material forming and molding, ease of assembly and disassembly, weight, cost, and etc. A preliminary drawing of the chamber, including the auxiliary equipment, will be completed. The chamber materials and auxiliary equipment will then be purchased. The chamber will be constructed and its assembly completed in accordance with the drawing requirements. A PEM test matrix program will also be designed for chamber operational validation. PEM will be purchased for use in the validation program.

PHASE II: The assembled chamber will be mated with the required auxiliary equipment and operational verification will be completed. Each of the 13 items listed above will be validated for proper operation versus requirements. The drawing package will be finalized for approval and will include a parts and equipment list. Tests will be performed utilizing control parts. A control part data base will be established for future chamber calibration and operational verification. An equipment manual will be written providing the details for chamber operation; cleaning, disassembly and assembly procedures; maintenance requirements; and drawings. The PEM procured in Phase I will be subjected to the PEM test matrix. Test data will be gathered, as required, and failure rates determined for each matrix test element. This failure data will be used in conjunction with a previously developed accelerated aging model for model validation purposes. A standard test matrix will be developed for use with the chamber based on the success of the accelerated test model validation versus real time harsh environment storage data. The standard test matrix concept will be presented to IC suppliers and industry for approval and acceptance. The chamber concept, test program capability, and test data results will be presented at appropriate conferences and workshops. The harsh environment storage classification concept will also be presented at technical conferences and meetings. A final report will be issued upon completion of the program.

PHASE III DUAL USE APPLICATIONS: There are commercial industries that have very similar PEM harsh environment reliability degradation concerns as MICOM. Several of these industries follow: (1) paper pulp; (2) oil drilling, refining, and distribution systems; (3) military automotive and aircraft, (4) natural gas drilling and pipeline distribution systems, and etc. These industries use electronic equipment that is directly exposed to harsh chemicals containing ionic contaminants which can readily penetrate the PEM package and cause equipment failure. This chamber would allow these industries to have access to an accelerated testing capability that would provide reliability degradation answers to their operating system concerns. The microcircuit suppliers would also have access to this new test technology and could develop a harsh environment classification category for their IC part types as acceptable or not acceptable for use in harsh storage environments. This classification would alleviate reliability concerns when designers are selecting microcircuits for use in MICOM missile systems.

OPERATING AND SUPPORT COST REDUCTION: The development of the Microcircuit Epoxy Molding Compound (EMC) Environmental Evaluation Chamber (EEC) will provide a substantial contribution toward implementing cost savings for military hardware that will be subjected to long-term dormant storage in harsh environments. There presently is no reliability data base to support using PEM in harsh environments. The performance of the PEM test program using this chamber presents a win-win situation pertinent to Operating and Support Cost Reduction. Development of the chamber will allow a standard harsh environment PEM test program to be designed and approved by IC suppliers and industry. This will then allow an IC classification to be acceptable or unacceptable for use in hardware that must withstand harsh environments. This designation will satisfy the military and such additional users. Testing PEM part types and determining that they will not meet the harsh environment classification will prevent their use in hardware destined for harsh environments operation and storage. The composition of the epoxy molding compound is a constant variable between suppliers and also within a given suppliers various product lines. This is another reason that the moisture acceptability for each part type must be determined and classified. The development of the chamber and an approved standard harsh environment test program will reduce operation and support cost by reducing maintenance costs and equipment down- time. The classification selection capability will also reduce the design engineer's part type selection time.

A97-158 TITLE: Rapid, Low-Cost Processing and Assembly Methods for Filament Wound Composite Structures

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: To develop material systems and methods for fabricating and joining composite motorcase structures, and components which reduce the need for long curing times and expensive tooling.

DESCRIPTION: Conventional processing methods for filament wound composite motorcase structures are time-consuming and often require expensive tooling for fabricating the structure and loading the propellant. Current resin systems used in high-performance motorcase structures require long thermal curing times and result in excessive resin loss and manufacturing waste. In order to reduce manufacturing costs and enhance producibility, novel material systems, curing processes, and/or rapid joining techniques are needed. Processing enhancements must be achieved without adding weight or compromising the structural integrity of the motorcase.

PHASE I: Identify candidate material systems and processing methods which will allow more efficient fabrication and/or production of composite motorcase structures. Demonstrate the feasibility of integrating the most promising technologies into current and future tactical missile systems while maintaining structural performance.

PHASE II: Implement the processing approach identified in Phase I into represent filament wound composite motorcase structures and demonstrate the performance of the structure under realistic loading conditions. Process modifications will be made based on the test results. A final processing technique will be demonstrated through full-scale fabrication and testing.

PHASE III DUAL USE APPLICATIONS: The processing technology developed and demonstrated as a result of this research has significant commercial potential for filament wound composite pressure vessels for automotive or aircraft fuel storage tanks, fireman tankage, and fuel containers. Enhanced producibility and reduced manufacturing costs will also benefit composite structures for sporting goods, spacecraft and civil engineering applications.

OPERATING AND SUPPORT COST REDUCTION: Maintenance should be reduced for missile systems due to reduction or elimination of residual stresses in a composite rocket motorcase or launcher caused from thermal mismatches during cure. Main areas of improvement would include forward closures, nozzles, attachments, and appendages such as launch lugs.

Natick Research, Development, and Engineering Laboratory (NRDEC)

A97-159 TITLE: Applying Pressurized Airbeam Technology to Parafoils to Improve Stand-off Capability

KEY TECHNOLOGY AREA: Clothing, Textiles and Food

OBJECTIVE: To provide a personnel-size parafoil with inflatable airbeams to increase offset height and distance for safer clandestine insertion and reduced vulnerability.

DESCRIPTION: Experience with current ram-air parachutes indicates a limit on glide performance due to limitations in the structural rigidity of ram-air inflated shapes, as well as significant aerodynamic drag produced by the large number of suspension lines required by ram-air parachutes of moderate to heavy canopy loading. Integrating the innovative technology of pressurized airbeams with ram- air parachutes should produce a parafoil capable of maintaining its design shape under load, as well as reduce the required number of suspension lines. This effort will focus on experimentally validating the theoretically positive effects of stiffening a parafoil, using off- the-shelf equipment and techniques, and test assets organic to Natick.

PHASE I: This phase will concentrate on modifying and testing a standard, personnel sized ram-air parachute to include inflatable airbeam reinforcements. Two standard military ram-air parachutes will be identified and provided to the contractor for test assets. One parachute will be left unmodified, to be used as a control. The second parachute will be reinforced with inflatable airbeams. Testing of this parachute will consist of captured truck tow tests of a pre-inflated parachute. The glide performance of this system will be evaluated and compared to a standard ram-air parachute. A test matrix will be followed which allows the slow reduction of drag contributing factors, such as number of suspension lines, and inlet shape, and assesses the effects of each factor.

PHASE II: Upon the successful completion of Phase I, deployment of the airbeam-parafoil system would be evaluated. This will require integration of an inflation system, such as compressed air cartridges, into the airbeams. The staging of the parachute will be analyzed for the acceptable dynamic pressure ranges for deployment and inflation of the parachute. Upon successful demonstration, using ground-based testing, that the inflation system works reliably, low-level airdrop tests will be conducted. The Natick airdrop test site in Sudbury, MA may be utilized, followed by testing from USAF C-130 at Westover AFB. Results of this testing can be folded into the development of larger parafoils. Once proven, this research could support Natick STO'S.

PHASE III DUAL USE APPLICATIONS: This technology has several possible applications in the commercial market. The large offset distance potential of this technology is ideal for several areas, including remote fire observation, fire fighting, remote area rescue, border patrol, and drug enforcement. Inflatable airbeam technology is used in tents and other temporary structures.

OPERATING AND SUPPORT COST REDUCTION: Operational and Support Cost Reductions are anticipated for the airdrop equipment used to deliver items, the equipment being airdropped and the US Air Force delivery aircraft. Lower anticipated loss and damage rates will result from improved durability of the parafoil, decreased vulnerability of the delivery aircraft and increased stability of the parafoil at the drop zone. Manufacturing cost will be reduced by elimination of suspension lines. O&S Costs will be reduced in the time required to rig loads because of the reduction of suspension lines.

A97-160 TITLE: Multi-Directional Weaving of Parafoils

KEY TECHNOLOGY AREA: Clothing, Textiles and Food

OBJECTIVE: Demonstrate a new stitchless inexpensive ram air gliding wing-parafoil modular fabrication technique for precise long-distance cargo air drop.

DESCRIPTION: Current fabrication of parafoils requires design of rib patterns which are laid out and cut from broadcloth. They are then structured into cells by sewing the respective rib components between top and bottom fabric sheets, forming a parafoil. This fabrication technique is labor-intensive and costly. By applying multi- directional weaving technology to produce chordwise curved and tapered fabric tubes to be placed adjacent to one another between top and bottom fabric sheets and laminated inside a restraining tool a stitchless and precise parafoil system can be fabricated at a low cost.

PHASE I: Technical feasibility will be established by the design and fabrication of a 12-foot by 24-foot wide parafoil. The loom will be programmed to produce tapered and curved fabric tubes from precoated unidirectional yarns. Novel fabric patterns and shapings will be utilized to produce the parafoil. Utilization of an inflated membrane will provide pressure, forcing the fabric to adhere to one another at the adjacent wall and to the top and bottom fabric sheets, forming a stitchless and precise parafoil system.

PHASE II: Upon the successful completion of Phase I, parafoil deployment would be evaluated. This will require the integration of the stitchless parafoil with a suspension system. The system will be analyzed for the acceptable dynamic pressure ranges for deployment and inflation of the parafoil. Upon successful demonstration using ground-based testing, that the stitchless parafoil works reliably, low level airdrop tests will be conducted. Once the stitchless technique is proven the concept will be incorporated into the manufacturing of parafoils.

PHASE III DUAL USE APPLICATIONS: Other areas for exploitation exist in using the manufacturing process to produce cost-effective, high- tech parafoils in the commercial market. The weaving process lends itself to forming the multiple conical shapes required for construction in a process that can utilize seamless fabrication techniques in reducing manufacturing costs for inflatable survival devices (life rafts, life vests, etc.) through the elimination of adhesive or thermal bonding.

U.S. Army Simulation, Training and Instrumentation Command (STRICOM)

A97-161 TITLE: Distributed Simulation and Computing Applications for the Combined ArmsTactical Trainer (CATT) and Family of Simulations (FAMSIM)

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: To develop new and innovative solutions specific to CATT and FAMSIM problem/issue areas.

DESCRIPTION: The CATT program is developing a family of interoperable simulators for training a combined arms force in a real-time synthetic environment where the focus is sustainment training for collective tasks and skills in command and control, communication, and maneuver. The Close Combat Tactical Trainer (CCTT) focuses on Armor Close Combat and is the first of the family. CCTT can be represented as five major system elements: 1) manned simulators and staff workstations, 2) semiautomated forces (SAF), 3) DIS compliant network and protocols, 4) after-action review system, and 5) terrain and weapon performance databases. As the CCTT work progresses and the training requirements become more mature the need for additional technological work has been identified.

The PM FAMSIM is developing Wafighter Simulation 2000 (WARSIM), which is a next generation training simulation for commander and staff training from battalion through corps. This system replaces several current simulations, including CBS, BBS, TACSIM, and CSSTSS. To the maximum extent possible, users will interface with WARSIM through organic C4I systems. The combined needs of CATT and FAMSIM are outlined below. These needs appear in descending order of importance. Each proposal should clearly identify the specific area being addressed. Offerors may submit proposals for any or all areas.

a. SAF is a key component of the CCTT (and CATT) program. The SAF relies on operator inputs on the User Computer Interface (UCI) for direction on how the SAF entities should operate. Because the current SAF designs are Semi-Automated as opposed to fully autonomous the SAF system relies on the operator to provide most of the Mission, Enemy, Terrain, Tactics & Troops (METT-T) thinking. Most of the logic that would make a SAF fully autonomous is well beyond the capabilities of current SAF technology. The SAF operator control the entities based on METT-T and situational awareness to fill this technology void. Demands are placed on current SAF designs to extend their single UCI control to large numbers of entities upwards of the battalion level with a goal of a regimental/brigade level. In addition the SAF operators must be able to integrate with new C4I systems and coordinate with units that have a mix of manned simulators and SAF entities. Current SAF UCIs have a 2D (map) display that the operator uses for both determining situational awareness and entity control. Tools are available to aid in determining area visibility, ranges, event alerts and unit status. The 2D display has limitations in its ability of giving a 3D perspective to the SAF operator. Providing a 3D display also has limitations in cost and it is only limited to one area (or view) when a operator has units distributed throughout the battle area. The focus of this effort should be to research new display presentations which would provide the operator better situational awareness.

b. Wireless and cableless binocular simulator subsystem for CCTT. The binoculars must have miniature displays which will be able to fit into binocular housings. The housing must have the same form and fit as the actual U.S. Army military binoculars. The image must be transmitted to the binocular displays without any cables or connections. The current CCTT binocular simulation uses trainer unique controls to determine line-of-sight and magnification. The goal is to replicate binocular simulation as much as possible to real- world use and functionality.

c. There is a need to simulate digital communications at echelons battalion and above, in order to inject realistic battlefield effects during a command exercise using a constructive simulation. This simulation would be by exception and determined both prior to run-time and during the exercise by exercise controllers. This system should have discretionary monitoring capabilities for digital communications traffic to record communication degradation effects for after action review purposes.

d. The need exists to accommodate a wide variety of real-world command, control, communications, computers, and intelligence (C4I) equipment into the CATT synthetic environment. Currently, CCTT has integrated the SINCGARS Radio Model (SRM) developed by CECOM for transmitting and receiving digital voice and data. The initial SRM was computationally intensive and had to save computer cycles and to be hosted within the computational resources of individual simulators. In the future, other C4I systems will be required to be integrated into simulators, including those in the Army Battle Command System (ABCS). The communication systems used in conjunction with these C2 systems include SINCGARS SIP, EPLRS VHSIC, SDR, NTDR, FDR, MSE, etc. The purpose of this effort would be to develop a low cost innovative radio frequency modeling implementation for interfacing Radio frequency systems with a DIS simulation. Note: additional relevant technical information supportive of this area is available from DTIC.

e. CCTT is using a Fiber Distributed Data Interface (FDDI) Local Area Network (LAN) for distributing DIS packets. The need exists to maximize the number of packets that can be distributed locally over the network. The purpose of this effort is to explore innovative methods for data transfer both for the FDDI LAN and for transport over wide area networks (WAN).

PHASE I: Explore alternative concepts and develop feasible approach.

PHASE II: Implement best approach from Phase I with objective of proving feasibility and effectiveness of concept.

PHASE III DUAL USE APPLICATIONS: Commercial communication networks; commercial interactive network game/entertainment industry.

OPERATING AND SUPPORT COST REDUCTION: The CATT and FAMSIM Program's Exploratory Development Category topic directly and indirectly contributes to the Army's OSCR initiatives. For example, as the CATT program is directed toward the goal of providing a viable networked simulation alternative for field combined arms training while the FAMSIM program provides a viable simulation based surrogate for field based commander and staff exercises. Both programs reduce the "go to field" O&S costs for the Army.

A97-162 TITLE: Advancements in Distributed Interactive Simulation (DIS) and High Level Architecture

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: To develop new and innovative solutions to a set of specific problems/technical issues of interest to the Project Manager for DIS.

DESCRIPTION: DIS and HLA represent an umbrella concept for future simulations. It includes a synthetic environment within which humans interact through simulation at multiple networked sites using a compliant architecture, modeling, protocols, standards, and databases. PM DIS is actively pursuing the development of advanced technological applications of DIS and HLA and has identified several areas described below currently needing further research. These areas appear in descending order of importance. Each proposal should clearly identify the specific area being addressed. Potential offerors may submit proposals for any or all the areas.

a. Since the HLA has been designated as the standard technical architecture for all DoD simulations, the need exists to develop a prototype interface for transition of existing Army systems into HLA compliance. The offeror should address HLA compliance issues and associative resolutions, plus an indication of resource requirements. The compliance methodology proposed may address either a prototype interface mechanism or a simulation system architecture integration mechanism. In Phase I, the offeror will investigate the feasibility of HLA compliance in existing Army simulation systems. In Phase II, the offeror will develop a prototype methodology to achieve HLA compliance.

b. The need exists to develop and test prototype architectures to support the integration of C4I systems with virtual and constructive simulation. Specifically, integration of C4I systems with virtual and constructive simulations in the context of the Defense Modeling and Simulation Office's HLA development is an important application area having at least 3 open technical issues requiring research: 1) representation of information to be exchanged between the live C4I systems and virtual/constructive simulations via the HLA Run-Time Infrastructure (RTI); 2) the development of an effective concept for representing and exchanging perceived data between live C4I systems and virtual/constructive simulations via the HLA's RTI and determination of impacts on system bandwidth requirements, data logging, and after action reviews, and 3) determination of the effects of simulation based events, if any, on the live C4I system's performance. During Phase I, an offeror will be expected to review at least 3 candidate C4I systems and identify a common C4I system input/output for use in the Phase I and II research.

c. There is a need to develop techniques and methods to support the scalability of joint and theater echelon-sized entities to be controlled as Computer Generated Forces (CGF) for future large scale DIS exercises. Viable techniques/methods must support the transmission of C3I data through varying levels of aggregation and reflect appropriate behaviors at varying levels of aggregation due to inputs of C3I such as situation awareness reports, and FRAG orders.

d. It is perceived that the capability to dynamically change the fidelity of modeling in DIS CGF during operational exercises will be required. The goal of this effort is to develop multi-fidelity models for terrain, environmental effects, and behaviors. Correlation between models of different fidelity shall be emphasized. Models which must be represented with higher fidelity for soldier-in-the-loop simulators will be dynamically changed for increased fidelity. Other modeling in less significant areas of the simulation shall be modeled with less fidelity.

e. The ultimate operational goal of personnel responsible for the planning and implementation of large scale DIS/HLA exercises is to be able to begin the DIS/HLA exercises within 96 hours of receiving the "operational order". Two impediments to achieving that goal have been identified. They are: 1) the development of a tool or an implementable methodology for ensuring

the proposed exercise results in a "fair" fight, and 2) the development of a tool to time efficiently set all units in the data base such that they are doctrinally correct.

f. Many constructive simulations are available today that simulate logistics at the strategic level (mobilization, deployment, sustainment). These include entity level simulations of the strategic movement of Army forces and equipment from CONUS installations to the theater of operations. Most of these simulations are for planning and analysis purposes, and are not DIS nor HLA compliant. It is anticipated that strategic logistics will play an increasingly important role in future large scale DIS/HLA exercises. Therefore, the need exists to develop an automated and seamless interface between existing strategic level logistics simulations and DIS/HLA compliant systems operating in a distributed simulation environment. An interesting and possibly useful concept to consider may be that of a logistics agent. Such an agent would act as an interface between the existing non-DIS/HLA compliant logistic constructive simulation and other entities participating in the distributed simulation exercises. It is also envisioned that this agent would act as "a facilitator" in the sense it would permit and support the use of both the DIS training assets and the planning and estimation assets of constructive logistic simulations in an holistic manner.

g. For large scale DIS/HLA exercises to be run efficiently, automated exercise management is required. Two useful but currently unavailable features have been identified: 1) the capability to transfer ownership of entities to other entities during an exercise, and 2) the development of a tool to dynamically balance load where entity ownership transfer can be initiated both automatically & by operator action.

PHASE I: Unless otherwise stated, develop practical concepts, methodologies, and techniques in the above subject areas; and show feasibility for developed concepts.

PHASE II: Implement and demonstrate the best approaches resulting from Phase I activities.

PHASE III DUAL USE APPLICATIONS: Commercial communication networks; commercial interactive network game/entertainment industry.

OPERATING AND SUPPORT COST REDUCTION: PM DIS's Exploratory Development Category topic "Advancements in Distributed Interactive Simulation (DIS) and High Level Architecture (HLA)" indirectly contributes to the Army's OSCR initiatives. For example, DIS and HLA are infrastructure technologies, the primary focus of this topic. These infrastructure technologies lay the foundation for cost effective man centered networked simulation environments. These environments are viable alternatives to an all field training strategy and thus have overall impact of lowering the operating and support (O&S) costs of the Army. One of the major objectives of modeling and simulation as a whole is to reduce the overall costs of training the Warfighter and save time, money, and lives.

A97-163 TITLE: Non-System Training Devices and Training Instrumentation Systems/Technology

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: To develop new and innovative solutions specific to Program Manager, Training Devices problem/issue areas.

DESCRIPTION: The PM TRADE's mission is to plan, control, coordinate, and manage the development, acquisition, and fielding of effective training systems for use by the United States Army, other services, and designated foreign and domestic clients. Also, it manages the development, acquisition and fielding of instrumentation systems for the Combat Training Centers (CTC), Training Devices, Simulations, Simulators (TDSS) and Tactical Engagement Simulators (TES) for use during force-on-force training exercises. To be able to continue that mission into the 21st century, PM TRADE has identified the following areas for research and development investigation. These areas appear in descending order of importance. Each proposal should clearly identify the specific area being addressed. Potential offerors may submit proposals for any or all the areas.

a. The demand for terrain scenes which depict a user's own "backyard" or an area of potential conflict is great within the field artillery and other training communities. The development of a process to produce realistic terrain scenes for PC based systems would satisfy the user demand while significantly reducing acquisition costs for terrain scenes using current methods. Also, future training system acquisition costs could be reduced in that PC based visual systems could become the standard, while the need for expensive image generators would be reduced. Therefore, the need exists to develop new and innovative solutions which may be utilized to quickly develop low cost, photo realistic terrain scenes which allow artillery team members and other crews to perform self location; target detection, recognition and identification; and fire mission tasks within a visual environment which realistically represents the geographic location and terrain in which these soldiers train or in which they are expected to perform in the event of a conflict.

Current terrain scene production methods produce results which are either:

1) realistic in the sense of geographic location, replication of specific terrain features, and target motion but are costly and time consuming to produce, or

2) less time consuming to produce but are costly and appear animated with respect to terrain features and target motion.More specifically, PM TRADE's Guardfist II system utilizes a terrain scene production system whereby digitized photographs are bit mapped to produce a scene which is then correlated with digital terrain range and elevation data. Three dimensional moving target models and weapons effects are overlaid onto the scene, and many hours of manual labor are expended to ensure realistic target motion across the terrain, proper occulting of the target and weapon effect with respect to the terrain, and accurate correlation between the scene and range/elevation data. The resulting scene is excellent in terms of being able to represent a specific geographic location. Also, because the scene is produced from a photo of a "real" location, the artillery forward observer is able to use a "real" map of the location to become familiar with the terrain and to perform the all important self location task. This method also produces very realistic targets and target motion. The drawback is that each scene takes approximately six months to build, at a cost of approximately $100K.

Conversely, PM TRADE's AFIST system uses a moderately priced image generator which uses three dimensional rendering to create the entire visual scene, including terrain, targets and effects. The animated quality of the terrain scenes that this method produces does little to enhance training of forward observers or tank crewmen in self location, navigation and target identification tasks. Also, the hardware cost of this type of system makes it prohibitive for use on a training system that will be fielded to many locations.

The new process shall allow for quick (1 month) production of low cost terrain scenes for use on PC based training systems equipped with commercial off the shelf graphics cards. The process shall produce terrain scenes which have the realism of a bit mapped digitized photograph correlated to the appropriate range/elevation database. The minimum requirement is for a fixed eye location, with a 45 degree field of view of any terrain, including but not limited to, cities, urban, rural and of all climates. The process shall allow for the production of scenes which depict any geographic location, and the process shall incorporate properly occulted stationary and moving targets, as well as weapons effects into the scene. Use of existing terrain data bases such as unclassified Defense Mapping Agency (DMA) data is encouraged but not required.

b. In an effort to provide the Opposing Forces (OPFOR) with a safe and economical vehicle that is visually unique at the Maneuver Combat Training Centers, the Government has developed, from the M113 armored personnel carrier, a turreted OPFOR Surrogate Vehicle. The current M113/BMP2 Opposing Forces Surrogate Vehicle (OSV) provides thermal sight capability at the gunner's position with an M60A3 Tank Thermal Sight (TTS), model AN/VSG-2A. In an M60A3 tank, the commander views the same thermal image through an optical telescope which interfaces with the TTS to display the image for the commander. This optical telescope has not been integrated into the OSV due to optical complexity and space constraints. The requirement is for a low cost device that will display the same thermal image at the commander's position. The image shall have the same resolution and size as the gunner's image. The desired device shall provide the equivalent image in real-time and be capable of integrating into the existing vehicle's electrical system and space constraints.

c. Target recognition part task trainers are already in the works. The area in which we need further research is that of bringing scenes which are accurate with respect to "total scene thermal signature" into the world of real time gunnery simulators. Our short fall in training is not only in the area of thermal target recognition, but training a gunner on a platform equipped with a 2nd Generation FLIR on how to: defeat clutter, and counter measures; optimize level, gain, and focus; deal with temperature inversion; deal with weather and "bad FLIR days"; and optimize track gate sizing to obtain maximum Ph/Pk given only the thermal signature of a threat (with or without the complications stated above).

We must understand that the critical training task of the weapons of tomorrow is that of finding the target, optimizing it's thermal signature (not only for yourself but more critically for the computer/tracker), and handing the target off to the computer/tracker (usually via track gates). Once done, the only "gunnery" left is to pull the trigger. The old skill of laying of cross-hairs and what we used to call the art of gunnery is no longer the critical training issue. FLIR training and track gate optimization is the most important and critical training issue. To date we have no indoor gunnery simulations which account for these training requirements. The key is to have adequate scene content/definition in thermal without breaking the size/memory bank and enough processing power to update the scene in real time as the gunner manipulates his FLIR controls. We also need an algorithm that simulates the FLIR's effect on the scene as FLIR controls are manipulated. The system should have a large enough threat library to train the student in all scenarios with which he may reasonably be expected to encounter. There should be a complete set of typical threat platform thermal signatures in various states of operation, i.e., fired recently, engine on time, time of day, weather, etc. It should have an algorithm that simulates the characteristics of the weapon system's autotracker so that Ph/Pk and chance of "loss of lock" are properly played dependent on the quality of track gate sizing performed by the trainee gunner all true to the flight equations of the munitions being employed and other details. These challenges are big enough in stand alone gunnery trainers. The problem is magnified when we start talking about playing all of the above in a networked combined arms tactical trainer where one player may be trying to hand off a target to another shooter.

PHASE I: Explore concepts design possibilities in the above subject areas; develop concepts for each of the relevant design possibilities: and show the feasibility for concepts developed.

PHASE II: Taking the results of Phase I, take the most promising concept, design, or approach and develop and demonstrate.

PHASE III DUAL USE APPLICATIONS: The proposed developments would have application in many commercial environments (i.e. communications, entertainment).

A97-164 TITLE: Advancements in Individual Combatant Simulation Technology

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: To develop new, innovative and cost effective technological solutions to support immersive simulations for the individual combatant, consistent with the emerging High Level Architecture (HLA). Uses for the simulations include mission rehearsal, training and materiel development of soldier systems

DESCRIPTION: Until recently the inclusion of the individual combatant as an integrated participant in combined arms simulation based exercises was considered impractical. Advancements in virtual environment (VE) technology have reached a point at which visual, tracking and primary user input interfaces are becoming mature enough to support immersion of the individual in VE. For any of these efforts to be successful, the illusion they seek to create must be sufficient to cause the individual soldier to suspend belief while in the VE to the extent he believes his actions or inactions could cause harm to himself or to other entities within the virtual battlefield. This illusive phenomena is called presence, which has a sensory component and a functional component. The sensory component includes providing the appropriate stimulus to the senses while the functional component consists of the functionality of other objects in the VE that the individual interacts with, such as weapons, radios, stethoscopes or other tools. To achieve the users' desired level of presence in VE will probably take years of research and development. The goal of this topic is to move the technology in an incremental fashion toward an acceptable state of presence with functional components in VE to support individual combatant simulation requirements, as they emerge. All current VE interface technologies suffer from limitation, even the more mature visual, tracking and primary user input technologies. In no instance does the interface technology match human capabilities for the relevant sensory modality. Several challenges regarding this topic have been identified. These areas appear in descending order of importance. Each proposal should clearly identify the area(s) being addressed. Potential offerors may submit proposals for any or all the area.

a. Simulation and/or stimulation of the capabilities of the Land Warrior/Force XXI system, including the Integrated Helmet Assembly Subsystem (IHAS), Weapon Subsystem, Computer/Radio Subsystem, and Software (Tactical & Mission Data) Subsystem is needed. Simulation/stimulation of the Land Warrior system is necessary to assist in evaluating the operational effectiveness of the system (in support of the Army Milestone III decision), to assist in evaluating proposed future enhancements to the system, and for accurate modeling of the system's functionality to facilitate training in a networked synthetic environment.

b. Advancement in the state-of-the-art of precision gunnery training for existing and emerging (e.g., Objective Individual Combat Weapon, existing weapons equipped with the new Integrated Weapon Sight, the Land Warrior-modified M4) small arms weapons systems is needed. Small arms precision gunnery training requires extremely high precision (< 1 mm positional accuracy) and low latency tracking in order to determine the instantaneous weapon aiming vector needed for simulated ballistics computations and exact impact location within a three-dimensional synthetic scene presented to the trainee.

c. Advancement of behavior and modeling of computer generated forces (OPFOR and BLUFOR Infantry) is needed for intelligent and doctrinally correct interaction and decision making of CGF dismounted infantry when networked with manned simulator modules (e.g., individual combatant and armored vehicles)in the VE. Efficient algorithms for host processing, and graphical rendering are required.

d. Low latency, unencumbering, wireless, interference-free, and accurate instrumentation of the individual combatant's body, weapons, and tools to support advanced tactical training, MOUT operations training, and live-virtual exercises. High bandwidth interfaces to transfer instrumentation data to remote host computers, and to transfer communications/intelligence data to and from remote computers are required.

e. Innovative technologies/designs for providing low cost eye-limited resolution with a very large instantaneous field of view in head mounted display systems. High resolution visual imagery over a wide field of view is commonly considered to be another significant contributor to presence. However, high resolution imagery is only necessary over a relatively small portion of the field of view.

f. Methodologies for rapidly (<48 hours) creating terrain and associated feature databases for individual combatant simulation applications with tactically relevant resolutions (micro-terrain) are needed. Both off-line pre-processing and real-time/on-line methodologies are sought. Development of an effective methodology for transforming legacy databases into databases with required resolution for individual combatant applications is required.

PHASE I: Explore concepts, methodologies, design possibilities in the above subject areas. Develop concepts for each of the relevant possibilities and show the feasibility for the concepts developed.

PHASE II: With the results of Phase I, take the most promising concept, design, or approach to develop and demonstrate the technology.

PHASE III DUAL USE APPLICATIONS: The proposed developments would have application in many commercial markets, including entertainment, communications, and instrumentation.

OPERATING AND SUPPORT COST REDUCTION: The Advancements in Individual Combatant Simulation topic directly or indirectly contributes to the Army's OSCR program initiatives. For example, development of simulation technologies requested in this topic will reduce the Army's dependency on expensive military maneuvers and live-fire range munitions for training infantry soldiers. In addition, development of these computer technologies may be used by the Army to reduce the cost of maintenance, inventory control, and other tasks in which remote human-computer interaction is required.

U.S. Army Topographic Engineering Center (TEC)

A97-165 TITLE: Scene Generation Quality Assessment

KEY TECHNOLOGY AREA: Modeling and Simulation (M&S)

OBJECTIVE: Provide a mechanism, understandable by a viewer, to assess the ability of a three-dimensional scene to support an intended usage. This assessment should be based at a minimum on aspects of the topographic information that went into the scene, along with any supporting data and rendering techniques used to make the scene.

DESCRIPTION: Capabilities to produce three-dimensional scenes with increasing complexity are rapidly developing in both the military and industrial base. New topographic data sources and increased access to archival information are becoming more available as sensors, information, and communication technology improve. Stunning, often geotypical scenes can be generated easily for gaming applications with little utility for localized site planning or project assessment. The impact and limitations of various data sources and their accuracies are often masked from the viewer. The use of texture, modeling techniques, attribution, metadata, and terrain processing routines can further affect the appropriate application of generated scenes, causing confusion and misuse.

PHASE I: Investigate and document the generic components and procedures of the scene generation process. Identify and rank critical levels of quality for the various scene generation components and the procedures. Recommend methods for establishing and portraying a scene generation quality assessment. Document the process.

PHASE II: Implement the quality assessment methodology in an appropriate format. A computer assisted checklist/assessment system or visual quality depiction techniques should be considered. Provide demonstrable tools and assist in their use on existing and emerging Army programs to predict and depict the impact of quality for various applications of scene generation technology. Document the process.

PHASE III DUAL USE APPLICATIONS: Scene generation is widely used in the military sphere for activities such as training, planning, rehearsal, and command and control. The use in the commercial sector for site planning, project design, emergency response, legal mitigation, and virtual marketplaces is rapidly evolving as capable mass market hardware becomes available.

OPERATING AND SUPPORT COST REDUCTION: This topic provides support to the OSCR program by providing the Army with the capability to train in a realistic simulated environment. By using simulators, Army forces are not required to use actual equipment to train. Therefore, they are not using costly fuel and lubricants or causing wear and tear on their equipment. Additionally, training lands are not used reducing environmental impacts.

U.S. Army Space and Strategic Defense Command (SSDC)

A97-166 TITLE: Embedded Servo System Characterization

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop embedded servo analysis tools and techniques to provide loop gains, bandwidths, and other model parameters.

DESCRIPTION: There are numerous servo systems in operation at Kwajalein Missile Range (KMR) providing control of tracking systems for telemetry, radars, and optical telescopes. Generally, these systems are capable of exciting the systems and measuring responses at one or more locations in the control loops. The current servo analysis tools built into these systems are limited primarily to step and ramp responses with very little system model extraction. It is desired to determine automatically the loop gains, bandwidths, and other model parameters, as well as to determine mount imbalances.

PHASE I: Determine the necessary hardware, algorithms, and software to excite the servo system, measure responses, and extract the desired model parameters.

PHASE II: Install and demonstrate the system on a selected KMR sensor.

PHASE III DUAL USE APPLICATIONS: There are many commercial markets that make use of servo systems, such as space communications and factory automation, that could benefit from such embedded servo analysis.

OPERATING AND SUPPORT COST REDUCTION: This topic will provide automatic servo analysis and will reduce checkout time and manpower requirements. There are numerous servo systems at Kwajalein Missile Range and this should reduce staffing requirements.

A97-167 TITLE: Combined S-Band and Ultra-High Frequency (UHF) Feed for Kwajalein Mobile Range

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop a dual-frequency feed for the Kwajalein Mobile Range Safety System (KMRSS) telemetry systems.

DESCRIPTION: The KMRSS system uses a 10 foot dish, operating at 2200- Megahertz (S-Band) for telemetry reception, and a single helix mounted beside the dish, on the same pedestal, to transmit UHF command signals. The helix increases the size of the radome needed to house the system, increases the inertia and lowers the servo bandwidth of the system, and has less than ideal gain. A dual-frequency feed which uses the dish for both the UHF and S-Band signals should provide significantly better performance lowering system inertia, increasing servo bandwidth and eliminating the need for the helix. Due to the small diameter of the dish in terms of wavelengths, the design is challenging. The KMRSS is a shipboard system.

PHASE I: Perform studies and static range experiments to determine the optimum design for a dual-frequency feed and quantify potential improvements in system performance.

PHASE II: Implement, install, and test new feeds for the KMRSS systems.

PHASE III DUAL USE APPLICATIONS: Many commercial satellite control systems use an S-Band downlink and lower frequency uplink. The design will be useful in them.

OPERATING AND SUPPORT COST REDUCTION: This topic will replace two antennas with antenna which will reduce support costs. This will lower the parts count and maintenance time.