The Department of Defense

DoD Departments:

Department of the Army

Department of the Navy

Defense Advanced Research Projects Agency

Special Operations Command

OSD
DDR&E

Office of Secretary of Defense
Director Defense Research and Engineering

PROGRAM SOLICITATION 97.2
CLOSING DATE: 16 JULY 1997

FY 1997 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 97.2

**Small Business
Innovation
Research Program**

IMPORTANT

The DoD updates its SBIR mailing list annually. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E) found at the back of this solicitation or complete the electronic form at http://www.teltech.com/sbir/form.html. Failure to send the form annually will result in removal of your name from the mailing list.

If you have general questions about the Defense Department's SBIR program, please call the SBIR/STTR Help Desk at (800) 382-4634, or see the DoD SBIR/STTR Home Page, at http://www.acq.osd.mil/sadbu/sbir.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Opening Date: Thurs., May 1, 1997
Closing Date: Wed., July 16, 1997

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND
TECHNOLOGY

IMPORTANT NEW FEATURES OF THE DEFENSE DEPARTMENT'S SBIR PROGRAM

This solicitation reflects a number of important changes in the Defense Department's SBIR program that have been implemented over the past two years. The purpose of these changes is (1) to make the program more user-friendly to small firms and (2) to increase commercialization of SBIR research in military and/or private sector markets. The main changes are as follows:

1. **The Department's SBIR/STTR Help Desk** can address your questions about this solicitation, the proposal preparation process, contract negotiation, payment vouchers, government accounting requirements, intellectual property protection, the Fast Track, obtaining outside financing, and other program-related areas. You may contact the Help Desk by:

   - Phone: 800-382-4634 (8AM to 8PM EST)
   - Fax: 800-462-4128
   - Email: SBIRHELP@us.teltech.com

2. **The SBIR/STTR Home Page (http://www.acq.osd.mil/sadbu/sbir)** offers electronic access to answers to commonly-asked questions, sample SBIR proposals, model SBIR contracts, abstracts of ongoing SBIR projects, early releases of the SBIR solicitation, the latest updates on the SBIR program, information on the Small Business Technology Transfer (STTR) program, hyperlinks to sources of business assistance and financing, and other useful information.

3. **The Department now gives its highest priority for Phase II award to SBIR projects that qualify for the "Fast Track" by attracting independent third-party investors.** These Fast Track projects also receive interim funding between Phases I and II as well as expedited processing. See Section 4.5 of this solicitation for complete information on how to participate in the Fast Track. Thus far, almost all projects qualifying for the Fast Track have received interim funding and a very high percentage have been selected for Phase II award. Approximately 10 percent of the Phase II awards resulting from the 1996 SBIR solicitations are Fast Track projects.

4. **You may contact the DoD authors of solicitation topics to ask questions about the topics** before you submit a proposal. Procedures for doing so are discussed in Section 1.5(c) of this solicitation. Please note that, to ensure competitive fairness, you may talk by telephone with a topic author to ask such questions only during the six weeks preceding the date on which the solicitation officially opens. At other times, you may submit written questions, and all such questions and the responses will be posted electronically on the Internet for general viewing.

5. **All companies submitting a Phase I or Phase II proposal must complete a Company Commercialization Report (Appendix E)** -- a simplified listing of the commercialization status of the company's prior Phase II efforts (see Section 3.4(n)).

6. **An SBIR proposal that meets the goals of a solicitation topic but does not use the exact approach specified in the topic will still be considered.** For further information on this new Department policy, see Section 4.1 of this solicitation.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Defense Advanced Research Projects Agency (DARPA), Special Operations Command (SOCOM), and Office of the Secretary of Defense (OSD), hereafter referred to as DoD Components, invite small business firms to submit proposals under this solicitation for the Small Business Innovation Research (SBIR) program. Firms with the capability to conduct research and development (R&D) in any of the defense-related topic areas described in Section 8.0, and to commercialize the results of that R&D, are encouraged to participate.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific, technical, and commercial merit and feasibility of ideas submitted under the SBIR Program. Phase I awards are typically up to $100,000 in size over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific, technical, and commercial feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications.

Subsequent Phase II awards will be made to firms on the basis of results of their Phase I effort and the scientific, technical, and commercial merit of the Phase II proposal. Phase II awards are typically up to $750,000 in size over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable prototype. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to obtain funding from the private sector and/or non-SBIR Government sources to develop the prototype into a viable product or non-R&D service for sale in military and/or private sector markets.

This solicitation is for Phase I proposals only. Only proposals submitted in response to this solicitation will be considered for Phase I award. Proposers who were not awarded a contract in response to a prior SBIR solicitation are free to update or modify and re-submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III, and all awards are subject to the availability of funds. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Proposer Eligibility and Limitations

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of the research and/or analytical work in Phase I must be carried out by the proposing firm. For Phase II, a minimum of one-half of the research and/or analytical work must be performed by the proposing firm. The percent of work is usually measured by dollars of labor effort, although proposers planning to subcontract a significant fraction of their work should verify how it will be measured with their DoD contracting officer during contract negotiations. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Primary employment with a small business concern precludes full-time employment at another organization. Deviations from the requirements in this paragraph must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, all research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia. Work subcontracted by the small business to others may be performed outside the United States if, in the view of DoD evaluators of the company's proposal, such work will result in the transfer of foreign technology, knowledge, or resources to the United States, or otherwise serve the SBIR program's goal of commercialization of new technology in U.S. military and/or private sector markets.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.4 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counselor from the employees' Government agency for further guidance.

1.5 Questions about the SBIR Process and Solicitation Topics

a. General Questions/Information. The DoD SBIR/STTR Help Desk is prepared to address general questions about this solicitation, the proposal preparation process, contract negotiation, payment vouchers, Government accounting requirements, intellectual property protection, the Fast Track, financing strategies, and other program-related areas.

The Help Desk may be contacted by:

Phone: 800-382-4634 (8AM to 8PM EST)
Fax: 800-462-4128
Email: SBIRHELP@us.teltech.com

The DoD SBIR/STTR Home Page offers electronic access to answers to commonly asked questions, sample SBIR proposals, model SBIR contracts, abstracts of ongoing SBIR projects, early releases of the SBIR solicitation, the latest updates on the SBIR program, hyperlinks to sources of business assistance and financing, and other useful information.

DOD SBIR/STTR
HOME PAGE: http://www.acq.osd.mil/sadbu/sbir

b. General Questions About a DoD Component. General questions pertaining to a particular DoD Component (Army, Navy, Air Force, etc) should be submitted in accordance with the instructions given at the beginning of that Component's topics, in Section 8.0 of this solicitation.

c. Technical questions about solicitation topics. Approximately six weeks before this solicitation officially opens on May 1, 1997, the solicitation topics are released electronically on the DoD SBIR/STTR Home Page (**http://www.acq.osd.mil/sadbu/sbir**), along with the names of the topic authors and their phone numbers. This early release gives proposers an opportunity to ask technical questions about specific solicitation topics by telephone before the solicitation opens.

Once a solicitation opens, telephone questions will no longer be accepted, but proposers may ask written questions through the SBIR Interactive Topic Information System (SITIS), in which the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing. Proposers may submit written questions to SITIS via the DoD SBIR/STTR Home Page -- see the shortcut menu at the top of the Page. Alternatively, proposers may submit written questions to SITIS via e-mail, fax, paper mail, or telephone as follows:

Defense Technical Information Center
MATRIS Office, DTIC-AM
ATTN: SBIR Coordinator
53355 Cole Road
San Diego, CA 92152-7213
Phone: (619) 553-7006
Fax: (619) 553-7053
Email: sbir@dticam.dtic.mil

The SITIS service for this solicitation opens on or around March 20, 1997 and closes to new questions on June 16, 1997. SITIS will post all questions and answers on the Internet (see shortcut bar at the top of the DoD

SBIR Home Page), from March 20, 1997 through July 16, 1997. (Answers will also be emailed or faxed directly to the inquirer if the inquirer provides an email address or fax number.) Answers are generally posted within seven working days of question submission.

1.6 Requests for Copies of DoD SBIR Solicitation

To remain on the DoD Mailing list for the SBIR and STTR solicitations, send in the Mailing List form (Reference E). You may also order additional copies of this solicitation from:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

The solicitations can also be accessed via Internet through the DoD SBIR/STTR Home Page at **http://www.acq.osd.mil/sadbu/sbir**.

1.7 SBIR Conferences and Outreach

The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. For information on these events, see our Home Page (**http://www.acq.osd.mil/sadbu/sbir**). We have a special outreach effort to socially and economically and disadvantaged firms.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR Sec. 121.103. The term "number of employees" is defined in 13 CFR Sec. 121.106. Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially and economically disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management of the business.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any Federal Agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal Government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing a product or non-R&D service for sale (whether by the originating party or by others), in Government and/or private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic, although need not use the exact approach specified in the topic (see Section 4.1). Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation, including the instructions in Section 8.0 of the DoD component to which you are applying.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Sec. 5.5.
- Limit your proposal to 25 pages (excluding Company Commercialization Report).
- Use a type size no smaller than 12 pitch or 11 point.
- Do not include proprietary or classified information in the project summary (Appendix B).
- Include a copy of Appendix A, Appendix B, and Appendix E as part of the original of each proposal. (Additional copies of all Appendices can be downloaded from **http://www.acq.osd.mil/sadbu/sbir**).
- Do not use a proportionally spaced font on Appendix A and Appendix B.

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding Company Commercialization Report (Appendix E), (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, and a maximum of 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding Company Commercialization Report (Appendix E)) will not be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed copy of Appendix A, Appendix B and Appendix E.

a. Cover Sheet. Complete and sign Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summaries of proposals selected for award will be publicly released on the Internet and, therefore, should not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.

(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Commercialization Strategy. Describe, in approximately one page, your company's strategy for converting your proposed SBIR research into a product or non-R&D service with widespread commercial use -- including private sector and/or military markets.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local Governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of two-thirds of the research and/or analytical work in Phase I, as measured by dollars of labor effort, must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support of Similar Proposals or Awards. *Warning* -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the solicitating agency or agencies before award.

If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another Federal Agency or DoD Component or the same DoD Component, the proposer must so indicate on Appendix A and provide the following information:

(1) Name and address of the Federal Agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by <u>name</u> as well as by number of <u>hours</u> dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase I proposal.

n. Company Commercialization Report on Prior SBIR Awards. All small business concerns submitting a Phase I or Phase II proposal must complete Appendix E (Company Commercialization Report), listing the commercialization status of the concern's prior Phase II efforts. (This required proposal information shall not be counted toward proposal pages count limitations.) A Report showing that a small business concern has received no prior Phase II awards will not affect the concern's ability to obtain an SBIR award.

3.5 Bindings

Do not use special bindings or covers. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal Format

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation.

Each Phase II proposal must contain a Cover Sheet (Appendix A), a Project Summary Sheet (Appendix B), and a Company Commercialization Report (Appendix E). In addition, each Phase II proposal must contain a two-page commercialization strategy, addressing the following questions:

(1) What is the first product that this technology will go into?
(2) Who will be your customers, and what is your estimate of the market size?
(3) How much money will you need to bring the technology to market, and how will you raise that money?
(4) Does your company contain marketing expertise and, if not, how do you intend to bring that expertise into the company?
(5) Who are your competitors, and what is your price and/or quality advantage over your competitors?

<u>Copies of Appendices along with additional instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.</u>

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. A proposal that meets the goals of a solicitation topic but does not use the exact approach specified in the topic will be considered relevant. (Prospective proposers should contact the topic author as described in Section 1.5 to determine whether submission of such a proposal would be useful.)

Proposals found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the Government and the nation considering the following factors.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror. Evaluators may also consider the effect of work that the proposer anticipates subcontracting to others for performance outside the United States, as discussed in Section 1.3.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution.
- **b.** The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization. In particular, proposals that show strong evidence of commercial potential by qualifying for the Fast Track (Section 4.5) will receive the Department's highest priority for Phase II award, and a significantly higher percentage of such proposals will be selected for Phase II award.
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic.
- **d.** The qualifications of the proposed principal/key

investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror. Evaluators may also consider the effect of work that the proposer anticipates subcontracting to others for performance outside the United States, as discussed in Section 1.3.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by Government personnel.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

a. The small business concern's record of commercializing SBIR or other research, particularly as reflected in its Company Commercialization Report (Appendix E).

b. The existence of second phase funding commitments from private sector or non-SBIR funding sources -- especially matching commitments provided under the Fast Track (see Section 4.5).

c. The existence of third phase follow-on commitments for the subject of the research.

d. The presence of other indicators of commercial potential of the idea, including the small business' commercialization strategy (discussed in Sections 3.4h and 3.6, above).

If a company chooses to submit a third phase follow-on commitment per (3) above, the commitment should state that the small business or a third party will provide follow-on funding in Phase III, and indicate the dates on which the funds will be made available. The commitment should also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms should not be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment should be submitted with the Phase II proposal.

4.5 SBIR Fast Track

a. In General. On a two-year pilot basis, the DoD SBIR program will implement a fast-track SBIR process for companies which, during their Phase I projects, attract independent third-party investors that will match both phase II SBIR funding and interim SBIR funding (between Phases I and II). As discussed in detail below, companies which obtain such third-party matching funds and thereby qualify for the SBIR Fast Track will receive (subject to the qualifications described herein):

(1) Interim funding on the order of $40,000 (generally, $30,000 to $50,000) between Phases I and II;

(2) The Department's highest priority for Phase II SBIR funding; and

(3) An expedited Phase II selection decision and, upon selection, an expedited Phase II award.

b. How To Qualify for the SBIR Fast Track. To qualify for the SBIR Fast Track, a company must submit the following items, within 120 days after the effective start date of its Phase I contract, to the same address the company would send its Phase II proposal (see back of Appendix D):

(1) A completed fast-track application form, found at Appendix D. (IMPORTANT: Please also send a copy to OSD SBIR -- see back of Appendix D.)

(2) A commitment letter from an independent third-party investor -- such as another company, a venture capital firm, an "angel" investor, or a non-SBIR Government program -- indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, contingent upon the company's receipt of interim and Phase II SBIR funds. For guidance on what types of relationships between a small company and outside investors in the company meet the conditions for the Fast Track, see "Official Fast Track Guidance" on our Home Page (**http://www.acq.osd.mil/sadbu/sbir**), or contact the DoD SBIR Help Desk (tel. 800/382-4634).

The matching rates are as follows:

(a) For companies that have 10 or fewer employees and have never received a Phase II SBIR award from DoD or any other Federal Agency, the minimum matching rate is 25 cents for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $10,000 and $187,500 respectively for the two awards.)

(b) For companies that have received 5 or more Phase II SBIR awards from the federal Government (including DoD), the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $40,000 and $750,000 respectively for the two awards.)

(c) For all other companies, the minimum matching rate is 50 cents for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $20,000 and $375,000 respectively for the two awards.)

The commitment letter should indicate that the third-party funds will pay for work that is connected to the particular SBIR project, and should describe the general nature of that work. The work funded by the third-party investor may be additional research and development on the project or, alternatively, it may be other activity related to the project (e.g., marketing) that is outside the scope of the SBIR contract.

(3) A concise statement of work and cost proposal for the interim SBIR effort (if an interim option was not previously negotiated on the Phase I contract). The statement of work should be under 4 pages in length, and the cost proposal should be under 1 page in length.

(4) A concise report on the status of the Phase I project, if required by the DoD component that is funding the project. This report should be under 4 pages in length.

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project, unless a different deadline for fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component.

(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released. For example, a company whose matching rate is 50 cents to the dollar must certify, to the satisfaction of its DoD contracting officer, that it has received $20,000 in cash from the third-party investor before the contracting officer will release $40,000 in interim SBIR funds. Similarly, the company must certify that it has received $30,000 in third-party funds before the contracting officer will release a $60,000 installment of phase II funds. (A simple letter stating that the third-party funds have arrived, with an attached copy of the bank statement, should generally suffice.)

Failure to meet these conditions in their entirety and within the time frames indicated will generally disqualify a company from participation in the SBIR Fast Track. Deviations from these conditions must be approved in writing by the contracting officer. If disqualified, the company will still be eligible to compete for a Phase II SBIR award through the regular procedures.

c. Benefits of Qualifying for the Fast Track. A company which qualifies for the Fast Track will:

(1) Receive interim SBIR funding on the order of $40,000 (generally, $30,000 to $50,000), commencing at the end of Phase I.

Note: It is DoD policy that the vast majority of Phase I contracts which qualify for the Fast Track will receive interim SBIR funding. However, the DoD contracting office has the discretion and authority, in any particular instance, to deny interim funding to a Phase I contractor when doing so is in the Government's interest (e.g., when the project no longer meets a military need).

(2) Receive the Department's highest priority for Phase II award. Specifically, it is DoD policy that the percentage of fast-track Phase I projects which receive Phase II awards will be significantly higher than the overall percentage of Phase I projects which receive Phase II awards. (Historically, roughly one-third of Phase I projects at DoD receive Phase II awards.)

(3) Receive notification of whether it has been selected for a Phase II award, within an average of two months -- and, in all cases, no longer than ten weeks -- after the completion of its Phase I project.

(4) If selected, receive its Phase II award within an average of five months from the completion of its Phase I project.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than January 16, 1998. *The DoD Components anticipate making 450 Phase I awards from this solicitation.* On average, 1 in 8 Phase I proposals receive funding.

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately one-third of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the Government,* covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the Government to award a Phase II contract. See special instructions for each DoD Component in Section 8. *(For Phase I projects which qualify for the SBIR Fast Track, the instructions in Section 4.5 supersede those in this paragraph.)*

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. See special instructions for each DoD Component in Section 8.

5.3 Phase I Report

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A blank SF 298 is provided in Section 9.0, Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:
   - (a) Approved for public release; distribution unlimited.
   - (b) Distribution authorized to U.S. Government Agencies only; contains proprietary information.

(3) Block 13 (Abstract) of the SF 298, "Report Documentation Page") must include as the first sentence, "Report developed under SBIR contract". The abstract must identify the purpose of the work and

briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract will be published by the DoD, it must not contain any proprietary or classified data.

(4) Block 14 (Subject Terms) of the SF 298 must include the term "SBIR Report".

c. Submission. SIX COPIES of the final report on each Phase I project shall be submitted to the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, 8725 John J Kingman Road, Suite 0944, Ft. Belvoir, VA 22060-6218.

5.4 Other Reports

If asked, the contractor will be required to provide DoD with a report during Phase II, and each year for five years after completion of Phase II, detailing: (1) the revenue from sales of new products or non-R&D services resulting from the SBIR project, and (2) the sources and amounts of non-SBIR, non-STTR funding received from the Government and/or private sector sources to further develop the SBIR technology.

5.5 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly payments may be made. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.6 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)_________of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The Government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

If all of the information on a particular page is proprietary, the proposer should so note by including the word "PROPRIETARY" in both the header and footer on that page.

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.7 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.8 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a period of five years to allow the awardee to pursue a patent.

5.9 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation generally remain with the contractor, except that the Government obtains a royalty-free license to use such technical data only for Government purposes during the period commencing with contract award and ending five years after completion of the project under which the data were generated. Upon expiration of the five-year restrictive license, the Government has unlimited rights in the SBIR data. During the license period, the Government may not release or disclose SBIR data to any person other than its support services contractors except: (1) For evaluational purposes; (2) As expressly permitted by the contractor; or (3) A use, release, or disclosure that is necessary for emergency repair or overhaul of items operated by the Government. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252.227-7018, "Rights in Noncommercial Technical Data and Computer Software -- SBIR Program."

5.10 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.11 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.12 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical work must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical work must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

The percentage of work is usually measured in dollars of labor effort, although proposers planning to subcontract a significant fraction of their work should verify how it will be measured with their contracting officer during contract negotiations.

5.13 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of Government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller

General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The Government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.14 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The Government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M). The Manual is available on-line at http://www.dis.mil or in hard copy from:

Defense Investigative Service
1340 Braddock Place
Alexandria, VA 22314
Phone: (703) 325-5324

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED APPENDIX A (COVER SHEET), APPENDIX B (PROJECT SUMMARY), AND APPENDIX E (COMPANY COMMERCIALIZATION REPORT).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, July 16, 1997. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than July 8, 1997 or (b) it was sent by mail and it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U.S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the Government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding Company Commercialization Report). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the Government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals. The written request should be sent to the DoD organization that notified the proposer that the proposal was not selected for award.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) provides information access, much of it at no cost, to assist SBIR participants in bid-making decisions and in the preparation of proposals.

DTIC, a major component of the DoD Scientific and Technical Information Program, serves DoD as well as other federal agencies and their contractors by managing the technical information resulting from by DoD-funded research and development.

DTIC also provides access to specialized reference services and subject matter expertise within the DoD-sponsored Centers for Analysis of Scientific and Technical Information (IACs) which are concerned with engineering, technical and scientific documents and databases worldwide.

For the majority of SBIR topics, DTIC prepares a Technical Information Package (TIP), a bibliographic listing of DoD-funded work in technical areas relating to the topic. TIPs also may include information provided by the topic author and references to other information sources.

Firms participating in SBIR are strongly encouraged to request the TIPs for their solicitation topic areas. Requests can be made online via the DTIC SBIR Home Page on Internet, by sending Reference B at the back of this solicitation, or by telephone, fax, or email.

DTIC will return requested material, along with a user code, good for the remainder of the fiscal year for use in obtaining additional information or technical reports. A firm may receive a total of ten technical reports at no cost from DTIC during a solicitation period. Additional reports, custom bibliographies, and services outside the solicitation period may be charged to a major credit card or an NTIS deposit account.

Internet services, accessed via the DTIC SBIR Home Page (http://www.dtic.mil/dtic/sbir), include TIPs as well as current DoD SBIR and STTR Solicitations and Award Abstracts publications. Solicitation and awards information is also accessible via gopher (gopher.dtic.mil) on port 70, or file transfer (asc.dtic.mil). The FTP login is "anonymous", password is your E-Mail address, SBIR files are in the /pub/sbir directory. Also on Internet is SITIS for technical questions and answers concerning DoD topic descriptions. See section 7.2 for a complete description of this important service.

Call, or visit (by prearrangement) DTIC at the location most convenient to you. Written communications must be made to the Ft. Belvoir, Va., address.

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)
(703) 767-8228 (FAX)
EMail sbir@dtic.mil
WWW http://www.dtic.mil/dtic/sbir

DTIC Boston Regional Office
Building 1103, 5 Wright Street
Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Dayton Regional Office
2690 C Street, Suite 4
Wright-Patterson AFB, OH 45433-7552
(513) 255-7905

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600 (PH)/ (703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
301 Tarrow, Suite 119
College Station, TX 77843-8000
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical areas in which DoD Components request proposals for innovative R&D from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B, C, D and E follow the Component Topic Sections. Appendix A is a Proposal Cover Sheet, Appendix B is a Project Summary form, Appendix C is an outline for the Cost Proposal, Appendix D is the Fast Track Application Form, and Appendix E is the Company Commercialization Report. A completed copy of Appendix A, Appendix B, and Appendix E, as well as a completed Cost Proposal, must be included with each proposal submitted.

Many of the topics in Section 8 contain references to technical literature or military standards, which may be accessed as follows:

- References with "AD" numbers are available from DTIC, by calling 800/DoD-SBIR or sending an e-mail message to sbir@dtic.dla.mil
- References with "MIL-STD" numbers are available from the DoD Index of Specifications and Standards (DODISS) at Internet address http://www.dtic.mil/dps-phila/dodiss
- Other references can be found in your local library or at locations mentioned in the reference.

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).

SUBJECT/WORD INDEX TO THE ARMY SBIR SOLICITATION

INDEX OF ARMY FY98 TOPICS

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

Also see OSCR topics A97-123 thru 132

U.S. Army Research Laboratory (ARL)

Also see OSCR topics A97-133 thru 140

U.S. Army Research Office (ARO)

Also see OSCR topics A97-141 thru 145

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

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

Also see OSCR topics A97-146 thru 147

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

A97-038	Compressed Voice Data over Variable Bit Rate ATM Adaptation Layer (AAL) Algorithm for Transporting
A97-039	Antennas for Satellite Communications-on-the-Move
A97-040	Low Power Helmet-Mounted Display Development
A97-041	New Multipath and Co-channel Interference Suppression Techniques for Digital Data
A97-042	Monolithically Integrated HgCdTe Staring Infrared Focal Plane Array (IFRPA)
A97-043	Photonic And Microwave Transmit/Receive (T/R) Modules For Optically-Controlled Phased Array Antennas
A97-044	Battle Damage Prediction (BDP)
A97-045	Real-Time Image Fusion Processor for Helicopters and Land Vehicles Navigation
A97-046	Wireless and PCS Sub-Networks for Near Term Digital Radio/ Future Digital Radio
A97-047	Transition to the Objective C4I Modeling and Simulation Development
A97-048	System Architecture Tool Design
A97-049	Micro-transmitter and Rangefinder
A97-050	Tools for Rapid Development of Graphical Information System (GIS) Applications
A97-051	Low Cost Ka Band Transmit/Receive (T/R) Module
A97-052	Investigation of Active Networking Components
A97-053	Enhanced Power Spectrum Analysis
A97-054	Application of Imagery and Advanced Rendering Techniques to Battlespace Command and Control
A97-055	ISDN Model for Near-Term Digital Radio (NTDR)
A97-056	Object-Based C2 Visualization Workstation Architecture
A97-057	Continuous Microoptical Surface Profile Etching in InSb and InAs to Provide High-Efficiency, Low-Cost Microoptical Components
A97-058	Intelligent Power Management and Distribution System for Shelters and Vehicles
A97-059	Knowledge-Based Doctrine Tool
A97-060	Closed Loop Position Updates for Low-Cost Inertial Systems
A97-061	Flexure Springs/Pulse Tubes for Linear Drive Cooler Applications
A97-062	Development of Affordable Multi-Spectral Windows
A97-063	Donor-Transparent System Data Interface

Also see OSCR topics A97-148 thru 150

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

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

Also see OSCR topics A97-151 thru 153

U.S. Army Missile Command (MICOM)

A97-065 Integral Missile Seeker Signal Processor Design, Development, and Implementation
A97-066 High-Speed, Precise, "No Moving Parts" Scanner for Use in a Compact Eyesafe Ladar
A97-067 Multiple Channel GHz Sample Rate Pulse Capture Module Development with Integrated InGaAs Detector Array
A97-068 Application of Epitaxial Liftoff (ELO) Technology to Microelectromechanical Systems
A97-069 Low Cost Tactical Pintle Motor Test Bed
A97-070 Video Transmission in a Non-Line-of-Sight Environment
A97-071 Scramjet Combustor Modeling
A97-072 Development of Generic Lethality/Warhead Performance Model for Guided Missile Systems
A97-073 Programmable High Speed Large-Format CCD Camera

Also see OSCR topics A97-154 thru 158

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

A97-074 Materials and Designs for High Expansion Ratio, Hybrid Shelters
A97-075 Glass-Embedded Polymeric Sheet Stock For Food Applications
A97-076 Residual Life Indicator (RLI)
A97-077 Development of Low-Cost Self-Sealing Chemical, Rain, Underwater Environmental Protective (E.P.) Closure System

Also see OSCR topics A97-159 thru 160

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

A97-078 Embedded Training Technologies

Also see OSCR topics A97-161 thru 164

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

A97-079 Detection and Discrimination of Static and Dynamic Targets
A97-080 Tracked Electric Hybrid Propulsion Vehicle Design Code
A97-081 Intelligent Articulated Ground Vehicle Joint
A97-082 Advanced Ground Vehicle Propulsion Technology
A97-083 CORBA-Based Simulation and Data Security for Distributed Object Processing
A97-084 Acoustic Pattern Recognition
A97-085 Front Seat Occupant Crash Protection in Ground Vehicles
A97-086 Transmissive Sacrificial Element For Eye Protection From Lasers
A97-087 Compression Ignition Engine Combustion Improvement
A97-088 Compression Ignition Engine Technology Insertion
A97-089 Acousto-Ultrasonic Defect Detection in Composite Armor Material
A97-090 On-Board Water Recovery Unit

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

A97-091 Applications of Artificial Intelligence to Radar Signal Processing
A97-092 Correction of Imagery Distortions Due to Optical Turbulence at Low Angles of Incidence
A97-093 Dynamic Built-In Test/Simulation (DBITS) Using Synthetic In-Band Visible/IR Scene
A97-094 High Output, Near-Monodispersed Bioaerosol Generator
A97-095 Six Degree-of-Freedom (DOF) Motion Simulation and Vibration Platform
A97-096 Digital Video Workstation

U.S. Army Research Institute (ARI)

A97-097	Improved Soldier Decision-Making in Urban Settings
A97-098	Computer-Based Human Gesture Recognition for Command and Control
A97-099	Dialogue-Based Language Training

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

A97-100	Cyanobacterial Inoculants for Arid Land Reclamation

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

A97-101	Physics-based, Dynamic, Multi-spectral, Multi-spatial Texture Generator for Synthetic Scenes for Cold Environments
A97-102	Rapid Measurement of Ice Density

U.S. Army Topographic Engineering Center (TEC)

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

Also see OSCR topic A97-165

U.S. Army Waterways Experiment Station (WES)

A97-104	Enhanced Buried Unexploded Ordnance Detection and Discrimination Technology
A97-105	Multiple Simulated Bomb-Fragment Explosive Launcher

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

A97-106	Non-Invasive, Non-Contact Physiological Sensor for Determining Heart Rate, Cardiac Output, Electrocardiogram, Breathing Rate, & Environmental Threats
A97-107	System for Improved Plasma or Platelet Storage
A97-108	Mode of Action of Insect/Arthropod Repellents
A97-109	Malaria Genome Research-Screening the Genome for Antimalarial Targets
A97-110	Systems for Improved Red Blood Cell Storage
A97-111	Non-Invasive Device and Method for Measuring Blood Hermatocrit
A97-112	Molecular Targeting of Botulinum Toxin to the Motor Nerve Terminal
A97-113	Simplified Systems for PCR-based Diagnostic Assays for Infectious Diseases
A97-114	Stable, Specific, High-Affinity Binding Molecules for ELISA-like Detection of Selected Toxins and Infectious Disease Pathogens
A97-115	Toxicity Test Kit Development
A97-116	Blood Processor for Donated Blood
A97-117	High-Impedance, Dry Physiological Recording Electrode
A97-118	Aircrew Management Device
A97-119	Parallel Processing of Quantum Chemical Calculations

U.S. Army Space and Strategic Defense Command (SSDC)

A97-120	Innovative Decision Aid
A97-121	Reduction of Coincidental and Intentional Electromagnetic Interference in Commercial-off-the-shelf (COTS) Electronics

A97-122 Error Modeling of the ALTAIR Real-Time Refraction Correction Model
Also see OSCR topics A97-166 thru 167

Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Initiatives

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

A97-123	Small Photon Battery
A97-124	Thermal Protective Coatings/Materials for Packaging Applications
A97-125	Automated Tomographic Inspection of Munitions
A97-126	High-Accuracy Speech Recognition In Noisy Environments
A97-127	Advanced Nonlinear and Hybrid Systems Control Technology
A97-128	Tele-Operated Mobile Fire Extinguishing System
A97-129	Advanced Munitions Packaging Materials and Manufacturing Technology
A97-130	Magnetic Sensors for Electronic Fuzes
A97-131	Moisture-Proof Coatings for Composite Materials
A97-132	Development of a Long-Wave Infrared Imaging Spectroradiometer

U.S. Army Research Laboratory (ARL)

A97-133	Innovative Fuel Cells
A97-134	Smart Fluids
A97-135	Production of Higher Performance Hydrogen-Absorbing Alloys/Composites for Battery Applications
A97-136	Portable Microwave Nondestructive Evaluation System
A97-137	Gun Tube Wear and Erosion Prevention
A97-138	Real Time Full Field Acoustic Inspection Sensors
A97-139	Pneumatic Device for the Insertion of Discontinuous Reinforcement Into Dry Fiber Preforms
A97-140	Identifier for Individual Biological Particles

U.S. Army Research Office (ARO)

A97-141	Gun Tube Liner Erosion and Wear Protection
A97-142	Amorphous Metal Alloy Matrix Composites for Structural Applications
A97-143	Sensors and Controls for Advanced Diesel Engines
A97-144	Improved Actuators for Smart Structures
A97-145	Multi-Sensor Technologies for Detection of Unexploded Mines

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

A97-146	Advanced Materials for Helicopter Propulsion Systems
A97-147	Turboshaft Engine and Rotorcraft Drive System Technology

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

A97-148	Advanced High-Energy Polymer Electrolyte Batteries
A97-149	The Development of Generic Spatial Reasoning Modules to Support the Construction of Robust, Context-Sensitive Data Fusion Algorithms
A97-150	Tactical, Multifuel, Man-Portable Battery Charger

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

A97-151	Biologically-Generated Multi-Spectral Obscurants
A97-152	Optimization and Modeling of Genetic and Bioreactor Parameters of Recombinant Protein Products
A97-153	Hand-held Biological and Chemical Detector

U.S. Army Missile Command (MICOM)

A97-154 Polarization Coupling Analyzer for Interferometric Fiber Optic Gyroscope (IFOG) Sensor Coils
A97-155 Passive Moving Target Indication (MTI) and Tracking of Point and Sub-resolved Targets

A97-156 Production Techniques for Thin Film Thermal Battery Manufacturing
A97-157 Design and Development of a Microcircuit Epoxy Molding Compound (EMC) Environmental Evaluation Chamber (EEC)
A97-158 Rapid, Low-Cost Processing and Assembly Methods for Filament Wound Composite Structures

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

A97-159 Applying Pressurized Airbeam Technology to Parafoils to Improve Stand-off Capability
A97-160 Multi-Directional Weaving of Parafoils

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

A97-161 Distributed Simulation and Computing Applications for the Combined Arms Tactical Trainer (CATT) and Family of Simulations (FAMSIM)
A97-162 Advancements in Distributed Interactive Simulation (DIS) and High Level Architecture
A97-163 Non-System Training Devices and Training Instrumentation Systems/Technology
A97-164 Advancements in Individual Combatant Simulation Technology

U.S. Army Topographic Engineering Center (TEC)

A97-165 Scene Generation Quality Assessment

U.S. Army Space and Strategic Defense Command (SSDC)

A97-166 Embedded Servo System Characterization
A97-167 Combined S-Band and Ultra-High Frequency (UHF) Feed for Kwajalein Mobile Range

DEPARTMENT OF THE ARMY
97.2 TOPIC DESCRIPTIONS

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 assessmentsthroughout 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: <u>High Strength, Lightweight Cable/Tape for Cargo-Handling Winches</u>

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, 25μm 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 μm laser transmitters and eyesafe micro-laser rangefinders (μLRF). The μLRF shall consist of a 1.5 μm laser transmitter that weighs less than 4 oz, emits approximately >50μJ 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 μLRF 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 μm 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 (μLRF) 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 μm micro laser transmitter with high peak-power is also necessary for applications such as target location and illumination. The μLRF 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 μLRF '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 μLRF 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 μLRF. Define requirements of the μLRF 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 μLRF for implementation. A breadboard prototype, μLRF 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 μLRF concepts and construction of μLRF system. Prototype design of the μLRF shall be evaluated. A μLRF 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 wili 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 μm, 3-5 μm, 8-12 μm, 1.06 μm and 1.54 μm.

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., ½-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 1-6°C 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 spectroradiometer 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.

NAVY
PROPOSAL SUBMISSION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper ((703) 696-8528). The Deputy SBIR Program Manager is Mr. John Williams ((703) 696-0342). Inquiries of a general nature may be brought to the Navy SBIR Program Office's attention and should be addressed to:

Office of Naval Research
ATTN: NAVY SBIR PROGRAM, CODE 362
800 North Quincy Street, RM 633
Arlington, VA 22217-5660

The Navy's SBIR program is a mission-oriented program which integrates the needs and requirements of the Navy, primarily through topics which address the Navy Science and Technologies areas and have dual-use potential. A total of 33 Science and Technology (S&T) areas (listed in table 1) have been identified. Navy topics will be funded from these areas according to a priority it has established to meet its mission goals and responsibilities. Additional information on the Navy and Navy SBIR Program can be found on the ONR Home Page (http://www.onr.navy.mil)

PROPOSAL SUBMISSION:

There are two ways to submit your SBIR proposal to the Navy. The Navy <u>WILL NOT</u> accept the Red Forms in the rear of this book as valid proposal submission forms of the Appendix A and B. Instead proposers must use **one** of the following procedures **(but not both)**:

1. <u>Online Submission (through the Internet)</u>

A. Go to the ONR Homepage (address --http://www.onr.navy.mil), click on "Business Opportunities", then click on "Navy SBIR Online Submission Interface".
B. Submit your Appendix A and B via the Online Submission option. Make sure that you follow instructions to complete the electronic transfer of the appendices.
C. Print out and sign the Appendix A and B form.
D. Submit the signed Appendix A and B form along with one original and four copies of your entire proposal (including 4 copies of the signed Appendix A & B form) to the Navy SBIR Program Office at the above address. Mark the outside of the envelope with your topic number.

2. <u>Diskette submission</u>

A. Obtain the Navy SBIR Appendix A and B program (Sbir_ab.exe). This program is available from the Navy SBIR Bulletin Board (through the Internet) or you can request a copy of it on disk from the above address (please specify the computer platform PC or Mac).
B. To download this program from the Internet: go to the ONR Homepage (address --http://www.onr.navy.mil), click on "Business Opportunities", click on "Navy SBIR/STTR Bulletin Board", click on "Electronic Data Entry Forms". Click on "SBIR" under the heading for "Proposal cover sheets: Appendix A and Appendix B" or scroll down to the "For Macintosh

Users" section for Mac versions.

C. To run the program, double-click on it in File Manager (in Windows 3.1) or Windows Explorer (in Windows '95), or for Mac versions, open it in your spreadsheet application.

D. Data enter information.

E. Save file with .dat extension.(Do not save in a word processing format)

F. Print out and sign the Appendix A and B form.

G. Submit the signed Appendix A and B form along with one original and four copies of your entire proposal (including 4 copies of the signed Appendix A & B form) together with a disk containing the .dat file generated from the Appendix A and B program to the Navy SBIR Program Office at the above address. (Please note we do not want the entire proposal text on disk, just the Appendix A and B.) Mark the outside of the envelope with your topic number.

ABOUT THE NAVY SUBMISSION AND THIS SOLICITATION:

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award. If you have been invited to submit a Phase II proposal to the Navy by the TPOC, obtain a copy of the Phase II instructions from the Navy SBIR Bulletin Board on the Internet or request the instructions from the Navy SBIR Program Office. All Phase I and Phase II proposals should be sent to the Navy SBIR Program Office (at the above address) for proper processing. If the Program Office is unaware of the proposals in the system, they can not be tracked. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I and II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. The Navy will not accept Phase I proposals in excess of $70,000 (exclusive of the Phase I option). The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II); 2) a transition or marketing plan (formally called a "commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan for further R&D if the transition plan is evaluated as being successful. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II Option will be limited to 40 pages (unless otherwise directed by the TPOC or contract). The transition plan should be in a separate document.

The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY AREAS	SCIENCE AREAS
Aerospace Propulsion and Power	Atmospheric and Space Science
Aerospace Vehicles	Biology and Medicine
Battlespace Environment	Chemistry
Chemical and Biological Defense	Cognitive and Neural
Clothing, Textiles and Food	Computer Sciences
Command, Control and Communications	Electronics
Computers, Software	Environmental Science
Conventional Weapons	Manufacturing Science
Electron Devices	Materials
Electronic Warfare	Mathematics
Environmental Quality and Civil Engineering	Mechanics
Human-System Interfaces	Ocean Science
Manpower, Personnel and Training Systems	Physics
Manufacturing Technology	Terrestrial Sciences
Materials, Processes and Structures	
Medical	
Sensors	
Surface/Undersurface Vehicles/Ground Vehicles	
Modeling and Simulation	

NAVY TOPIC TITLES

OFFICE of NAVAL RESEARCH

N97-100 TITLE: Group III Nitride Bulk Crystals

N97-101 TITLE: Integrated Cooling Planes in Vertically Arrayed High Temperature Superconducting Device Circuits

N97-102 TITLE: High-Power Mid-Infrared Diode Laser

N97-103 TITLE: Advanced Antenna Concepts

N97-104 TITLE: Four-Dimensional (4-D) Atmospheric and Oceanographic Instrumentation

N97-105 TITLE: MCM Technologies for Detection, Classification, and Identification/Localization of Sea Mines and Submarines

N97-106 TITLE: Underwater Acoustic Communications Channel and Network Optimization

N97-107 TITLE: Light-Weight Satellite Sensors for Space Environment Sensing

N97-108 TITLE: Growth of Single Crystal Piezoelectrics

N97-109 TITLE: Miniature Diode Laser Velocity Sensor

N97-110 TITLE: Ultrasonic Diagnostic Imaging Transducers for Combat Casualty Care

N97-111 TITLE: Self Assembled Monolayer Based Methods for Materials Processing and Device Fabrication

N97-112 TITLE: Computer-based Training for Adult Literacy Enhancement

N97-113 TITLE: Detection and Tracking of Human Combatants by an Unattended Video Surveillance Device in Urban Environments

N97-114 TITLE: Biologically Motivated Neural Processing Architectures for Multi-Spectral Fusion

N97-115 TITLE: Remotely Operated Undersea Vehicle (ROV) Pilot Training System

N97-116 TITLE: Hard Target Penetrator End-Game Guidance

N97-117 TITLE: Virtual Laser - Kinematic Global Positioning System (GPS) Terminal Guidance from Spotter to Projectile

N97-118 TITLE: Terminal Guidance for Mid-Caliber Naval Guns

N97-119 TITLE: Thermographic Technology Development for Real-Time Fault Detection

N97-120 TITLE: Intelligent Control Algorithms and PC-Based Software Tool Development for Multiple Effector Control Systems

N97-121 TITLE: Biologically Inspired Processor for All-Source Data Association and Fusion

N97-122 TITLE: Affordability Measurement and Prediction Technologies

N97-123 TITLE: Large Area Infrared Emissivity Controlled Surfaces

N97-124 TITLE: Vapor Phase Corrosion Inhibitors

N97-125 TITLE: 3D Virtual Workbench

N97-126 TITLE: Structural Health Monitoring Using Fiber-Optic Sensing

MARINE CORP SYSTEMS COMMAND

N97-127 TITLE: AAAV Surf Zone Simulation Model

N97-128 Canceled

N97-129 Canceled

N97-130 TITLE: Commercial Digital Camera Environmental Protection

N97-131 TITLE: Wide-Field-Of-View Anamorphic Lens

NAVAL AVIATION TEAM

N97-132 TITLE: Utilization of Fractal Based Models for Acoustic Signal Processing

N97-133 TITLE: COTS Real Time Unified Avionics Interconnect

N97-134 TITLE: Low-cost High-speed Optical Links for Advanced Avionics Data Networks

N97-135 TITLE: Advanced Ship Motion Forecasting for Expanded Aviation Operations

N97-136 TITLE: Advanced Targeting through Decision Aids

N97-137 Canceled

N97-138 TITLE: Interference Mitigation in Night Vision Goggle (NVG) Systems

N97-139 TITLE: Advanced signal processing and Display Concepts for airborne Active ASW Systems

NAVAL FACILITIES ENGINEERING CENTER

N97-140 TITLE: Rapid Cargo Throughput for Sea Based Logistics

N97-141 TITLE: Relocatable Crane Technology for Use on Floating Platforms

N97-142 TITLE: Integrated Control of A Powered Causeway Ferry

N97-143 TITLE: Multiple Access RF Communication Protocol

N97-144 TITLE: Inflatable Boat Propulsion System

N97-145 TITLE: Tactical Tracking and Inventory System

NAVAL SUPPLY SYSTEMS COMMAND

N97-146 TITLE: Environmentally-Safe, Disposable Food Service Utensils

BUREAU of NAVAL PERSONNEL

N97-147 TITLE: A Tool to Optimize the Predictive Accuracy of Personnel Selection and Classification Instruments

N97-148 TITLE: Diagnostic Cognitive Task Analysis of Team and Multi-team Training

N97-149 TITLE: Diagnostic Tool for Reengineering Team Training Using Cognitive and Team Process Analyses

SPACE and NAVAL WARFARE SYSTEMS COMMAND

N97-150 TITLE: Target Imagery Classification System

N97-151 TITLE: Interactive Audio Human System Interface

N97-152 TITLE: Wide Range Tunable Filter

N97-153 TITLE: Security for Reprogrammable Electronic Devices

N97-154 TITLE: Transmission of Critical Aircraft Flight/Emergency Data via JTIDS/MIDS (Lx Band)

N97-155 TITLE: High Energy Density Battery

N97-156 TITLE: Application of Standard Network Technologies to Surveillance Arrays

N97-157 TITLE: Code Analysis Tools for High Integrity Systems

N97-158 TITLE: Detection using a Generalized Hough Transform Track- Before- Detect Processing of Split Horizontal Line Array Cross-Correlations

N97-159 TITLE: Generic Multiple Access Module Prototype for the PRIDE (Programmable Intelligent Digital Electronics) System

N97-160 TITLE: Broadband Signature Information Identification and Extraction

N97-161 TITLE: Shipboard Auto-Tracking with a Stabilized Platform

N97-162 TITLE: Physics-Based Signal Processing Techniques For Next Generation Naval Systems

N97-163 TITLE: High Performance Elastrometric Boot materials for Advanced Low Frequency Sonar Projector Applications

N97-164 TITLE: Reengineering of Distributed Source Code

NAVY SBIR PROGRAM MANAGERS OR POINTS OF CONTACT FOR TOPICS

TOPIC NUMBERS	POINT OF CONTACT	PHONE
100 - 126	Mr. Douglas Harry	703-696-4286
127 - 131	Mr. Joe Johnson	703-784-4801
132 - 139	Ms. Carol Van Wyk	301-342-0215
140 - 145	Mr. Andy Del Collo	703-325-8533
146	Mr. Dennis Gaddis	717-790-7435
147 - 149	Dr. Frank Vicino	619-553-7612
150 - 164	Ms. Linda Whittington	703-602-1031

DEPARTMENT OF THE NAVY
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
SUBJECT/WORD INDEX

NAVY 97.2 TOPICS

OFFICE of NAVAL RESEARCH

N97-100 TITLE: Group III Nitride Bulk Crystals

OBJECTIVE: To demonstrate growth technology for commercially viable semiconductor grade gallium nitride, indium nitride or aluminum nitride bulk crystals.

DESCRIPTION: The Navy has identified future requirements for Ultraviolet Detectors, radiation-hard high-voltage solar cells and solar blind detectors. These devices will be fabricated from epitaxial aluminum and gallium nitride and their alloy semiconductor epitaxial films. Suitable substrates for these epitaxial films are not yet commercially available and techniques for their optimized commercial production not yet defined. Growth rates in excess of 500 micrometers per hour, and crystal diameters in excess of 1" are considered essential. An additional need is for high purity, oxygen free polycrystalline, powder or amorphous group III nitride source materials for bulk growth. Proposals are requested for investigative research directed toward commercial production of 25 to 50 mm and larger diameter semiconductor grade GaN, AlN, and InN bulk single crystals. Special attention will be paid to proposals addressing flux growth from liquid metallic phases. It is expected that proposals will address time-scales, estimated substrate pricing, anticipated boule dimensions and production capability. Techniques that utilize non nitride substrates and seeds or that cannot approach growth rates of 1 millimeter per hour or higher will be considered non-responsive.

PHASE I: Contractor will develop technology concept for preparation of single crystal bulk GaN, AlN, InN, or alloys such as AlGaN. Target boule diameters and lengths in the first phase would be 25 mm and 100mm respectively, with extended defect densities below 10^7 cm^{-3}. Phase 1 study should identify technology to enable 50 mm diameter boules to be attempted in phase II. full technical report would be deliverable at end phase 1.

PHASE II: Proof of concept by demonstration of growth rates of 1 millimeter per hour or higher. Contractor will develop production scale technology for single crystal nitrides, and develop technology for production scale growth larger size boules. Target diameters and lengths are >50mm and 200mm respectively, with extended defect densities below $10^6 cm^{-3}$. Feasibility of much higher growth rates are also desirable. Contractor should address cutting and polishing approaches in phase I and demonstrate capability in phase II.

PHASE III: Contractor will transition bulk nitride growth and "wafering capability to commercial operation. Contractor should also supply bulk nitride crystals to DoD laboratories and contractor/grantees for characterization and evaluation of semiconductor/defect quality.

COMMERCIAL POTENTIAL: The commercial and military market for blue LED and laser diodes for display, data storage, and optical communications, is predicted to exceed $2B in 2001. The Navy and DoD need solar blind UV detectors for missile threat detection. Currently, although good detectivities are demonstrated, however substrate associated defects in devices on heteroepitaxial films, limit recovery speed and operational frequency. Applications in high power microwave communications are also limited by electrically active foreign substrate related defects.

N97-101 TITLE: Integrated Cooling Planes in Vertically Arrayed High Temperature Superconducting Device Circuits

OBJECTIVE: To develop a system for providing uniform cooling to temperatures of the order of 77K for a rigidly bonded, vertically arrayed set of substrates that have patterned circuits of high temperature superconductor (HTS) on them.

DESCRIPTION: HTS circuits will deliver greater performance advantages in electronics applications if they can be packaged into rigid vertical stacks which minimize the volume required, provide immunity to vibration related detuning of the circuits, and maximize the performance gain allowed by their low power consumption. Both commercial and military applications in wireless communications and high speed computing and signal processing favor operation relatively close to the material's transition temperature where the electrical properties are a strong function of their temperature. This will assure that entire vertical stacks of operating chips have a uniform and repeatable temperature distribution is highly desirable. The number of channels provided per base station and the sensitivity of the receiver are both increased by the improved filters which HTS has been demonstrated to provide, especially for the US assignment of carrier frequencies and in satellite operations. Provisions for electrical connection to any layer, preservation of the quality of the HTS material, and small contribution to microwave dissipation are required. Low loss rf leads must be provided between the planes and methods to control losses due to fringing fields from the circuit interacting with the cooling plane devised. Proof of concept experimental demonstration must be included using either YBCO or Tl??CO circuits on standard microwave substrates, to include quantification of the temperature gradients and demonstration of structural integrity and continued operation of stack after >50 thermal cycles.

PHASE I: Contractor will devise and simulate a scheme for bonding double sided HTS chips on opposite sides of an isothermal plane cooled by a single-stage, closed-cycle cryocooler.

PHASE II: Contractor will generalize the techniques developed in Phase I to vertical structures containing multiple cooling planes. Experiments should include demonstrations of >5 pole rf filters and HTS interconnects servicing CMOS chips. Proof of concept demonstration of ability to include ferroelectric tuning circuits desirable. Factors determining the relative virtues of increasing circuit area by increasing the area of individual chips vs. increasing the number of layers in the stack should be identified. Lower limits should be established on the mean time to failure of such stacks.

PHASE III: Contractor will transition the packaging technology that has resulted into the development of platform specific wireless and personal communications systems. Insertions as specialty service providers into programs developing high performance computers and specialized function signal processing circuitry is also expected.

COMMERCIAL POTENTIAL: Cellular communications is an industry currently experiencing explosive growth both in the developed world due to the convenience and in the underdeveloped world due to the lower cost of providing the required transmission facilities and other infra- structure. The existing performance advantages will be further enhanced if the device cooling can be incorporated into the basic circuit design without sacrificing rf performance rather than added on. Hybrid superconducting/semiconducting computers are also expected to deliver improved performance in the high end market.

N97-102 TITLE: High-Power Mid-Infrared Diode Laser

OBJECTIVE: To develop a high power compact 3-5 micron diode laser.

DESCRIPTION: Mid-Infrared lasers emitting in the 3-5 micron spectral band have potential applications in radar, laser-guided weapons, laser rangefinders, electro-optical systems which support improvement of capabilities in missile defense and surveillance sensors, remote sensing of atmospheric constituents, wavelength specific medical applications, and spectroscopy. Currently, 3-5 micron diode lasers are based on InAsSb/InAlAsSb, and InAs/GaInSb type II structures. First approach resultedin low power, low temperature laser due to small valence band offsets. Second approach resulted in low power laser due to increased number of interfaces in the laser structure. The purpose of this investigation is therefore to produce high power, high operating temperature lasers emitting in the 3-5 micron spectral band. The research efforts will be directed towards developing a single frequency mode laser leading to internally frequency modulated laser.

PHASE I: Demonstrate the fundamental technologies necessary to produce high power, high temperature 3-5 micron lasers. Design improved /new laser structures and show how the design improvements can be used for these IR laser.

PHASE II: Produce 3-5 micron lasers and demonstrate the high power, high temperature operation.

PHASE III: Develop reliable 3-5 micron laser arrays applicable for laser radar, laser-guided weapons, laser rangefinders, electro-optical systems which support improvement of capabilities in missile defence and surveillance sensors, and medical surgery, pump source,etc.

COMMERCIAL POTENTIAL: Potential applications include laser radar for aircraft and vehicles for collision avoidance, terrain mapping, remote environmental sensing, global wind sensing ,low altitude wind shear detection, toxic gas monitoring, ground water monitoring, (in the medical field)laser-base refractive surgery, miniaturized medical diagnostics equipment, (in the earth sciences field) infrared spectroscopy, range-finding for surveying and cartography. The added range available from a direct-generated laser will permit measurements from aircraft or remote sites without the need to place retroreflectors on the surveyed points. These semiconductor lasers will also be useful in battlefield situations in which toxic gases may be released. They will also be useful for monitoring ambient air quality in enclosed military vehicles(e.g., airplanes, submarines, etc.). Further, direct in-situ monitoring of materials important in military applications, such as lubricants, fuels and other liquids, e.g., water, can indicate purity, degree of degradation, etc. Applications are also possible in point-to-point data links to moving vehicles, and nuclear proliferation monitoring. The laser can be used for integration and characterization with the Multi-Band Anti-Ship Cruise Missile Tactical Electronics Warfare System(MATES), and other DOD related systems requiring directed IRCM.

REFERENCE:
H.K. Choi, G.W. Turner and H.Q Le, " GaSb-based Semiconductor Lasers in 4um Band," Institute of Physics Conference Series No.144, P.1 (1955)

N97-103 TITLE: Advanced Antenna Concepts

OBJECTIVE: To develop compact efficient, wide-bandwidth antennas for communications and multifunctional systems radar.

DESCRIPTION: Navy applications of compact antennas span nearly all frequency bands, from ELF to SHF. In the short wavelength bands, electronically-steered array applications would benefit from small element-to-element spacing because in such geometries, grating lobe structure would be reduced. Commercial applications involve MF, HF, VHF and UHF bands. In Navy applications, in the VHF and UHF bands, stealth characteristics in the antenna may also be desired. The proposal should describe how the antenna design is applicable to producing low radar cross-sections and to reducing other observable signatures that the antenna may posses. Operating frequencies of interest in the short wavelength regime span 2-20 Ghz.

PHASE I: Describe the theoretical considerations that will make the proposed wide bandwidth antenna both compact and efficient; how elements in an array configuration can be made to possess low radar cross-section and be low in other antenna-signature characteristics; and with a strawman design indicate the technologies that would be employed to fabricate the antenna and to insure that the unique features of the stated goal are achieved in practice.

PHASE II: Fabricate a compact active element or an array of such elements and demonstrate that wide bandwidth operation can be accomplished in a structure that is compact and with a performance that is efficient and free of excessive grating lobe structure.

PHASE III: Working with a commercial partner or a DoD organization, select a specific antenna application and work to achieve an antenna that satisfies the practical requirements of that organization.

COMMERCIAL POTENTIAL: Wide bandwidth antennas, of themselves, provide the opportunity to have a single antenna structure serve many antenna functions. This virtue is of particular benefit to radio frequency band users that have complex communications needs or needs to both communicate and perform object tracking functions. In some applications, a small physical size is desired which possesses electrically steered characteristics that are not degraded by grating lobe structures that arise from the inability to closely space active elements

N97-104 TITLE: Four-Dimensional (4-D) Atmospheric and Oceanographic Instrumentation

OBJECTIVE: Develop instruments/sensors/techniques to measure atmospheric and/or oceanographic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain marine atmospheric and oceanographic variables (e.g., physical, chemical, optical, geophysical and biological) in 3-D space and time. Regions of application include the air/sea environment of the open ocean, continental slope and shelf and the very nearshore surfzone; and concerns ocean bottom and sub-bottom as well. The instruments solicited can utilize active and/or passive measurement approaches covering either acoustic or E/M frequencies to support remote sensing or in-situ observations. The approach should be to obtain as complete a space and time characterization as possible and/or necessary for the application being considered. Priority is given to those projects which use off the shelf, low cost, low volume components, are of low power and long life, have been demonstrated to be reliable, particularly in harsh environments, and are easy to deploy. Deployment modes may be via autonomous underwater vehicles, piloted or remotely piloted aircraft, oceanographic buoys and moorings (ocean bottom and surface mounted), underway from a ship or aircraft, from a towed body, or in an expendable mode, or other. Some examples of areas of interest (not exclusive) are: (a) Instrumentation to provide 3-D sub-bottom swath imaging capability from which volume scattering strengths of sediments and buried objects; and size and depths of buried objects; (b) Affordable, off-the-shelf systems for measuring mean velocity in the surf zone and to track sediment movement; and (c) Instrumentation/observation techniques to characterize in-situ ocean velocity and scalar turbulence.

PHASE I: Develop a detailed design and engineering description of the sensor/instrumentation system. Include the expected resolution, sensitivity, precision, and accuracy of the variables being measured. Assess the usage of the device in a realistic environment. Detail risk factors of the design and the steps necessary to overcome these.

PHASE II: Develop prototype system, perform in-situ tests, evaluate and document system.

PHASE III: Transition the technology to scientists in the atmospheric, oceanographic and environmental monitoring research communities, to operational DoD systems, and to the commercial community.

COMMERCIAL POTENTIAL: New instruments can be used in a wide variety of commercial environmental monitoring systems.

N97-105 TITLE: MCM Technologies for Detection, Classification, and Identification/*Localization* of Sea Mines and Submarines

OBJECTIVE: Enable airborne and sea platforms to rapidly detect, classify, and identify (D/C/I) sea mines and other objects of similar size and of submarine size.

DESCRIPTION: Sensors used for D/C/I of mines have dramatically improved in recent years. These include airborne LIDAR, underwater laser systems, high resolution sonars, and magnetic sensors. This effort will develop, fabricate, and test sensor system improvements which overcome some of the severe performance limitations of existing sensors due to adverse environmental factors, such as sonar surface and bottom reverberation, especially in shallow waters less than 60 feet and when searching for potentially buried objects. Underwater laser systems are limited by water clarity problems which result in blur, glow, and absorption. Airborne LIDAR systems suffer from water surface reflections which must be gated out, reducing the sensors' capability to detect surfaced objects. These optical systems also suffer from reduced target contrast in bright daylight conditions.

ASW sonar systems are on the verge of increased capability in littoral wasters. Current designs are performance limited by severe multi-path propagation and reverberation/clutter. Greater computing power in today's signal processsors allow the possibility of sorting out the multi-path arrivals and de-cluttering the received signal. The development of wide frequency band systems, sources and receivers, will allow waveform designs not now available.

The proposed effort will develop technologies which can ameliorate one or more of today's sensor technology limitations.

PHASE I: Develop a technology design for overcoming underwater object sensing limitation(s). One or more designs addressing the same or different limitations is required. In addition, a document clearly explaining the theory of operation and predicted performance enhancement is required for each design.

PHASE II: Fabricate and test a breadboard (experimental) prototype of the sensor enhancement(s) and provide clear and complete documentation of the prototype's final design, functionality, and testing conducted to demonstrate performance improvement(s).

PHASE III: Design, fabricate and test advanced developmental prototype(s) with interfaces to existing and/or new technology sensors or sensor systems.

COMMERCIAL POTENTIAL: The technologies developed will have multiple commercial applications. Airborne LIDAR improvements will enhance the performance of air search and rescue sensors. Underwater technologies will enhance sensors used by commercial diving and salvage companies and the oil industry which uses sensors for oil pipe and cable relocation and inspection.

REFERENCES: Sea Technology (ISSN 0093-3651) published by Compass Publications, Inc., 1117 North 19th Street, Arlington, VA 22209

N97-106 TITLE: Underwater Acoustic Communications Channel and Network Optimization

OBJECTIVE: To optimally configure an underwater acoustic communications network to maximize surveillance functions, while minimizing the power used by sensor nodes, and to estimate the impulse response of an underwater acoustic channel, including time-varying arrival structure, Doppler, and frequency spreading characteristics, using only historical sound velocity profile (SVP), existing physical oceanographic data, sensors spatial properties, and motion dynamics of sensor platforms.

DESCRIPTION: Consider the case of a network (fixed or mobile) of sensor nodes and a master node. In order for most sensor nodes to communicate to the master node, a message must be relayed from sensor node to sensor node until it reaches the master node. The goal is to determine optimal communications routes from each sensor node to a master node and to be able to adapt to problems, such as changes in environment , sensor outages, etc. There are several unique challenges- node-to-node paths must be short due to underwater acoustic propagation limitations, to avoid draining a node's power prematurely there must be a limit to the number of routes each node can participate in, message rate and size are limited by power consumption constraints, and communications bandwidth may be limited to extend minimum communication range. The propagation path, which to a large extent is influenced by the characteristics of the physical ocean acoustic channel, affects node-to-node underwater communication. The acoustic channel impulse response provides an indication of multipath and frequency spreading characteristics of a particular channel. The problem is to determine a means to accurately describe the channel impulse response using only historical sound velocity profile (SVP), existing physical oceanographic data, sensors spatial properties, and motion dynamics of sensor platforms. The impulse response could then be used to initialize both coherent and non-coherent communication nodes' algorithms. This is particularly relevant to the operation of joint, adaptive synchronization and equalization algorithms.

PHASE I: Create an objective function and associated constraints for dynamically determining the optimal routing of the communications network. Develop models or modify existing models to predict the time-dependent ocean channel impulse response structure peculiar to a specific ocean environment, using only historical SVP data, *a priori* bathmetry data, and source/receiver depths. Validate the model by comparing its impulse response estimates with actual response data found in the literature and/or online.

PHASE II: Create a test bed to evaluate candidate communication routing algorithms. Incorporate an analytical tracker in a Monte Carlo simulation to quantitatively evaluate and compare the candidate algorithms. Develop appropriate Measures of Effectiveness (MOEs) to evaluate the candidate algorithms. MOEs should address the value added to the surveillance product for a message sent to the master node, and be incorporated into the objective function to weigh this against the power consumed by sending the message. Perform in-water experiments to validate the IR model predictions for selected ocean areas and two frequency regimes: 2-4 kHz and 10-40 kHz. The IR model predictions will be used to initialize the joint, adaptive synchronization and equalization algorithms in the tactical acoustic modems.

PHASE III: Implement one or more routing algorithms identified (in phase II) as most efficient for optimizing and controlling communications into a prototype master node. Implementation is to provide for dynamic control of the routing and the decisions as to send a message for a network of sensor nodes to be controlled by the master node. Integrate the IR model algorithms with existing tactical modem software/hardware and provide any additional software/hardware required to effect this integration.

COMMERCIAL POTENTIAL: Acoustic communications are currently being evaluated for applications in oceanographic research, underwater vehicles, and recreational diving. Optimal acoustic communications networks would be useful for communicating to researchers/drones when there is not a direct communications link. This technology would be applicable to needs wherever there is a requirement for remote underwater connectivity.

REFERENCES: Stojanovic, M., "Recent Advances in High-speed Underwater Acoustic Communications," *IEEE Journal of Oceanic Engineering,* April 1996.

N97-107 TITLE: Light-Weight Satellite Sensors for Space Environment Sensing

OBJECTIVE: To develop a new generation of light weight and/or in-situ or remote sensing instruments to fly aboard new generation of mini and micro satellites for space environment sensing.

DESCRIPTION: The trend towards smaller satellites combined with increasing delays for access to spaceflight point to the need for new generations of small, low weight and low power space sensors to take advantage of opportunities for space flight as secondary payloads. Environmental parameters of interest include the electron and ion densities in the ionosphere, magnetosphere and plasmasphere, and the energy and composition of the trapped and precipitating charged particle environment. Additional consideration will be given to light weight satellite bus technology and the development of new generations of small atmospheric sensors for remote sensing of temperature, density, composition and density. Many current space sensors are too large or require too much power to be accommodated on micro satellites. Sensors are needed for inclusion on satellites with total weights in the range 50 - 200 kg. Both in-situ instruments such as ion mass spectrometers and remote sensing sensors such as topside sounders and UV/X-ray imagers are considered. Sensors with minimal external pointing requirements, or innovative self-pointing on crude pointing platforms are needed. New detector technologies and innovative electronics packaging technologies are required. Small satellite buses with self-contained power, pointing, command data handling will also be considered.

PHASE I: Conduct and present a design study incorporating innovative and light weight/low power technology to develop a new generation of sensor for space or atmospheric sensing including tradeoffs between size, weight, power and performance.

PHASE II: Fabricate a laboratory version of the sensor. Test the sensor in the laboratory to verify sensing capability and evaluate instrument sensitivity and signal to noise ratio compared to design parameters. Perform environmental testing or modeling to ensure that instrument designs will address the rigors of the space environment.

PHASE III: Build a spaceflight qualified instrument for flight aboard a host satellite. Instrument must have completed and documented mechanical, electrical, command and telemetry interfaces. Adequate testing and calibration of the instrument must be completed to verify the functionality of the sensor and the suitability of the instrument for spaceflight on a mini or micro satellite.

COMMERCIAL POTENTIAL: A new generation of space sensing technology can be used to extend the life of commercial satellites by providing advanced warning of charged particle and space environmental hazards. Ionospheric sensing instruments will improve the operation of a number of commercial space systems which are currently affected by ionospheric variability on the propagation of radio frequency signals.

N97-108 TITLE: Growth of Single Crystal Piezoelectrics

OBJECTIVE: Grow single crystal piezoelectric materials for high performance acoustic transducer and electromechanical actuator applications.

DESCRIPTION: Recent research results have established that relaxor-based single crystal piezoelectrics have exceptional performance characteristics compared with conventional alternatives for acoustic transduction and electromechanical actuation, for example, electromechanical coupling exceeding 90%. These materials promise enhancements of more than an order of magnitude for broadband Navy sonar transducers and civilian medical diagnostic transducers, as well as for electromechanical actuators used in shipboard and civilian vibration control applications. To commercialize these materials, cost-effective crystal growth methods are sought which produce materials in the size and form required by these diverse application domains.

PHASE I: Demonstrate a crystal growth technique that yields piezoelectric single crystals with high electromechanical coupling and high actuator authority.

PHASE II: Develop a cost-effective crystal growth method and apparatus for the production of piezoelectric single crystals of size and form suitable for acoustic transducers and electromechanical actuators. Demonstrate performance in prototype device configurations.

PHASE III: Manufacture piezoelectric single crystals for processing into acoustic transducers and electromechanical actuators.

COMMERCIAL POTENTIAL: These high performance piezoelectric materials will have application in broadband ultrasonic transducers used in medical diagnostic imaging, and in high strain electromechanical actuators used for vibration control in air-conditioners, automobiles, and aircraft.

REFERENCES: Seung-Eek Park and Thomas R. Shrout, "Characteristics of Relaxor-Based Piezoelectric Single Crystals for Ultrasonic Transducers," Proceeding of the 1996 IEEE International Ultrasonics Symposium.

N97-109 TITLE: Miniature Diode Laser Velocity Sensor

OBJECTIVE: Develop miniature Laser Doppler Velocimetry (LDV) probes utilizing commercially available visible laser diodes, avalanche photodiodes, and miniature optical components, for fluid velocity measurements where space is constrained and only local battery power is available.

DESCRIPTION: The LDV measurement technique has unique characteristics including non-intrusiveness, fast response, and high accuracy. However the size, power requirement, complexity, or cost of standard LDV measurement systems often makes them impractical for many fluid velocity measurement tasks. Replacing ion gas lasers and photomultipliers with visible diode lasers and avalanche photodiodes would result in a significant cost reduction and an even greater reduction in electrical power and component size. This effort would develop a miniature two-component LDV probe suitable for size- and power-constrained applications.

PHASE I: Conduct a 6 month effort to evaluate components and design alternatives for a two component diode laser velocimetry probe. Produce a waterproof, working prototype probe for evaluation by the Navy.

PHASE II: Explore techniques to add laser beam frequency shifting or its equivalent to the diode laser based sensor and to produce a family of miniature LDV probes with various sizes, frequencies, power, and focal lengths.

PHASE III: Refine manufacturing techniques to increase robustness of the probes and to lower instrument costs. Produce and sell a commercial product that can be used with available LDV signal processors and software from other LDV equipment manufacturers.

COMMERCIAL POTENTIAL: Small, low power, LDV probes with completely self contained optics would open up many new applications areas for LDV in the marine, aerospace, chemical, and automotive vehicle industries. They would be particularly important to the nonintrusive measurement of flow around autonomous vehicles and models, and in remote locations with limited access.

REFERENCE: Coughran, M. and D. Fry, "Expected Capability of Multiple - Probe LDV Propulsor Inflow Measuring System," CDRKNSWC/HD-1308-01, (Feb. 1990).

N97-110 TITLE: Ultrasonic Diagnostic Imaging Transducers for Combat Casualty Care

OBJECTIVE: Devise, develop and fabricate medical ultrasonic imaging transducers with enhanced performance characteristics: sensitivity, bandwidth, or element count.

DESCRIPTION: The use of medical diagnostic imaging in forward echelons on the battlefield provides a means for the early diagnosis and effective treatment of combatant wounds, offering the possibility of reducing the nearly 50% of battlefield casualties who die on the field for lack of timely diagnosis and treatment. A critical component in these ultrasonic imaging devices is the transducer that generates the probing pulse as well as detecting the returning echoes. This topic seeks innovative transducer designs and fabrication methods that are particularly suited to the requirements of field deployable imagers for defense applications; such designs and methods should also be broadly applicable to civilian diagnostic imaging requirements in trauma care and more conventional application arenas.

PHASE I: Design, fabricate, and test prototype transducers that enhance performance in one or more operating characteristics over conventional transducer designs.

PHASE II: Develop a cost-effective method for manufacturing the new transducer design and demonstrate performance in a medical ultrasonic application for combat casualty care.

PHASE III: Manufacture the new transducers for application in medical diagnostic imaging devices used for combat casualty care as well as in standard civilian applications.

COMMERCIAL POTENTIAL: Medical ultrasonic diagnostic imaging transducers that meet defense combat casualty requirements will find even larger markets in civilian trauma care. The civilian medical ultrasonic imaging market -- approaching $2 billion in annual sales -- provides a substantial opportunity for any technology developed.

REFERENCES: Annual Proceedings of the IEEE Ultrasonics Symposium and Annual Proceedings of the American Institute of Ultrasound in Medicine Meetings

N97-111 TITLE: Self Assembled Monolayer Based Methods for Materials Processing and Device Fabrication

OBJECTIVE: To exploit the ability of self assembled monolayers (SAM) to process small scale features and/or to chemically or electronically passivate surfaces thereby aiding in the development of low cost manufacture, enhanced performance, and/or longer life of electronic and optical materials/devices.

DESCRIPTION: Recently there have been significant advances in the development of self assembled monolayer science and technology. The ability to pattern extremely small scale features and structures using self assembly "stamping" techniques has been demonstrated by a number of researchers. Much of the work to date has focused on defining the limits of this process for fabricating small scale features and the type of materials and structures which could be stamped. As this research has developed, more sophisticated issues such as registry in multi- layer patterns, printing on non-uniform surfaces, and sagging in stamps have emerged. It has also been demonstarted that SAMs can can be used to chemically passivate surfaces such as those of superconductors which leads to increased atmospheric stability of these materials. Still, a number of key issues remain to further develop a passivation process based on SAMs which can be extended to a variety of material systems (semiconductor and superconductor). The ease with which self assembled monolayer processing methods have been implemented in laboratories across the country suggests that they could be easily integrated into a variety of manufacturing processes for electronic and optical materials. This Phase I program is specifically designed to exploit and use SAMs in electronic and optical materials/device manufacturing processes.

PHASE I: The phase I effort will focus on design of electronic or optical materials/device fabrication processes which could see a significant reduction in manufacturing cost and/or a significant enhancement in materials/device performance as a result of implementation of this new SAM-based processing technology.

PHASE II: The phase II demonstration of the new process should delineate and focus on the key technical challenges to implement the SAM-based process in a real manufacturing environment. Preliminary cost analysis will be undertaken and verification of enhanced performance and reliability will be addressed as is appropriate.

PHASE III: Emphasis will be placed on implimenting a prototype manufacturing process which exploits the SAM-based processing developed in Phase I and II; cost, throughput, reliability and market issues will be fully addressed.

COMMERCIAL POTENTIAL: The commercial potential of SAM-based processing technologies is enormous. Typical methods to produce fine detailed structures in electronic and optical materials/devices require a large number of processing steps. By using SAM-based techniques the number of processing steps could be reduced, throughput increased and overall manufacturing cost lowered. Furthermore the use of SAMs for chemical and electronic passivation of materials and devices can significantly enhance the performance and lifetime of such devices.

N97-112 TITLE: Computer-based Training for Adult Literacy Enhancement

OBJECTIVE : Design, develop and evaluate training software to improve the reading competence of adults currently reading at the grade 5-9 level.

DESCRIPTION: The Navy has a need for computer-based training (CBT)/ educational software for use in developing the reading skills of naval personnel. This CBT must be suitable for use in independent study, without the support of an instructor or traditional classroom setting. It should be targeted for an adult student population rather than for a younger K-12 population. Further, it should be targeted for a population that has mastered basic reading skills of decoding and has attained a reading grade level of at least grade 5 and perhaps as high as grade 8 or 9. The aim would be to advance these readers towards grade 12 reading competence, the average competence of a high school graduate. There would also be interest in CBT that gives special attention to special needs of bilingual personnel whose first language is not English. Little is available that currently meets these requirements: adult literacy programs typically aim too low, at truly illiterate non-readers, whereas the content of programs designed for school children is usually inappropriate for adults. Offerers are invited to propose and argue for instructional approaches appropriate to obtain the stated goals. It is assumed that at least one appropriate element of an instructional approach would be computer-supported reading practice. For this purpose, the CBT should incorporate reading materials appropriate for the adult interests of a diverse population, including women and members of various cultural minorities. In addition, it should provide for Navy instructors or others to enter new, job-related materials with a reasonable amount of authoring effort. The project plan should include research that will test the effectiveness of the CBT instruction in improving reading competence, as well as plans for commercial productization.

PHASE I: Design and prototype CBT and authoring or entry of new practice materials.

PHASE II: Develop CBT, incorporate appropriate reading material libarary, obtain rights to materials, experimentally evaluate both training effectiveness and ease of authoring or entry of additional reading materials.

PHASE III: Transition CBT to Chief of Naval Education and Training shipboard and other learning center training and/or to comparable groups in the other military services.

COMMERCIAL POTENTIAL: CBT software has massive commercial potential for use in civilian educational institutions and/or in industrial remedial basic skills training programs.

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1. Frederiksen, J. R., Warren, B., and Rosebery, A. (1985)A componential approach to training reading skills: Part I. Perceptual units training. Cognition and Instruction, 2(2), 91-130.
2. Frederiksen, J.R., Warren, B.M., & Rosebery, A. S. (1986). A componential approach to training reading skills: Part II. Decoding and use of context. Cognition and Instruction, 2(3&4), 271-338.
3. Joyce Harvey-Morgan, Moving Forward the Software Development Agenda in Adult Literacy: A Report Based on the Adult Literacy Software Development Conference. Practice Report PR96-02, May 1996, National Center on Adult Literacy, University of Pennsylvania.
4. M. A. Just & P.A. Carpenter, The Psychology of Reading and Language Comprehension. Boston: Alleyn & Bacon, Inc. 1987.

N97-113 TITLE: Detection and Tracking of Human Combatants by an Unattended Video Surveillance Device in Urban Environments

OBJECTIVE: Design and build an inexpensive portable active vision unit that can be deployed in urban environments, that can function unattended, and that is capable of continuous monitoring of wide fields of view, detecting and tracking humans, determining if they are combatant, and reporting "suspicious" activity.

DESCRIPTION: Recent advances in PC and video hardware as well as algorithmic advances in pattern analysis from video---especially those inspired by the understanding of how the human visual system works ---are making possible a new generation of inexpensive real-time vision systems. This technology has been demonstrated in commercial computer systems for automatically locating humans in live video, extracting their faces, recognizing and tracking them. The current effort would use existing technology to develop a video surveillance system that has the additional capability of discriminating between combatant and non combatant personnel in the field of view in an urban environment. It would also be able to track human movement and determine if there are any "suspicious" patterns of activity. This necessarily would be an active vision system with pan/tilt zoom capabilities on the video camera(s) to allow operation over a wide field of view while at the same time being able to perform detailed pattern matching to determine if a person is a combatant. The system could use in addition infrared sensors integrated with the video camera to improve robustness of operation in reduced lighting conditions and to help spot carried weapons.

PHASE I: Develop overall system design that includes specification of video surveillance and recognition technology, sensor specification, and protocol of operation.

PHASE II: Develop and demonstrate a prototype system in a realistic environment. Conduct testing to prove feasibility over extended operating conditions.

PHASE III: Integrate cost effective systems for large scale field deployment.

COMMERCIAL POTENTIAL: This system could be used in security applications where automatic surveillance and tracking are necessary.

REFERENCES:

1. Alyea, L.A., Hoglund, D.E., Eds. Human Detection and Positive Identification: Methods and Technologies, SPIE, 1996.
2. DePersia, A., Yeager, S. and Ortiz, S., Eds. Surveillance and Assessment Technologies for Law Enforcement. SPIE, 1996.

N97-114 TITLE: Biologically Motivated Neural Processing Architectures for Multi-Spectral Fusion

OBJECTIVE: Develop software and later, hardware to perform multi-frequency fusion in real-time, with emphasis on the fusion of video data. Emphasis is on the integration of current sensor systems. No specific wavelengths are emphasized, rather any combination of the electro-optical-infrared (EOIR) spectrum is acceptable. The ultimate goal is a modular signal processor capable of integrating from 2-10 bands and producing a signal for a conventional color display.

DESCRIPTION: Current emphasis on "first on the scene" discrimination of strategic mobile targets (SMTs) requires an ability to fuse visual sensor-data in real-time. Biological systems which have fusion capability also exhibit color contrast enhancement, color constancy and target background separation with a low S/N. Suggested solution to the invisible spectrum fusion problem may make use of biological principles. The final product should embody a number of algorithms capable of image preprocessing using a variety of inputs from various sensors or multiple bands from a single sensor. This product should be modular or reconfigurable and adaptable to a wide range of applications.

PHASE I: Develop, test and operationally demonstrate a complete multi-frequency sensor fusion system. Compare with alternative methods, networks, and algorithms. Field test.

PHASE II: Produce and demonstrate a complete product incorporating lessons learned in Phase II. Possible Navy programs include TMD, Tomahawk, Advanced Avionics, Real-time Retargeting, and Smart Weapons.

PHASE III: Produce a complete product incorporating lessons learned in Phase II.

COMMERCIAL POTENTIAL: Imagery fusion in real time has application for civilian aircraft, any traffic (land, sea, air) control system, multi-media presentations, and human-machine interactions such as color contrast enhancement, color constancy and the reduction of S/N.

REFERENCE: Scribner, D. Infrared color vision. IRIS Proceedings on Targets Background and Discrimination. Jan '96.

N97-115 TITLE: Remotely Operated Undersea Vehicle (ROV) Pilot Training System

OBJECTIVE: Enable pilots of remotely operated undersea vehicles to develop and practice critical operational skills without requiring the use of expensive operational assets.

DESCRIPTION: Undersea ROV pilot training is generally obtained on the job and is often limited by the cost of system deployment, the lack of availability and the high cost of operational assets. A self-contained simulation-based training system would allow pilots to learn and practice critical skills prior to operation of the actual operational systems. For Navy applications, it is particularly desirable for the system to be low-cost and compact, allowing it to be used shipboard, in the classroom or in operational locations.

PHASE I: Design a self-contained prototype training system for ROV pilots. Address issues of critical skills to be taught, techniques and technologies to be incorporated including instructional strategies, portability, configurability, and cost. Perform feasibility demonstrations. Develop hardware and software specifications for prototype construction in Phase II.

PHASE II: Construct prototype of system designed in Phase I. Develop self-contained software package for operation of system. Perform formative evaluations of critical system components. Demonstrate effectiveness of system through training transfer tests, showing the utility of the system as used with a representative ROV system.

PHASE III: The prototype system will be applied and demonstrated for Navy mission areas, including mine countermeasures, search and salvage, and submarine rescue. Commercial applications will also be pursued as described below.

COMMERCIAL POTENTIAL: Increasing commercial use of ROVs has increased the need for training and certification of pilots. The off-shore oil and gas industry is currently the largest user of such systems (300-500 currently active in the field), and both personal and product liability issues are imposing the need for certified operators. Other areas requiring trained and certified operators include hydroelectric, inshore infrastructure and ship hull inspection.

N97-116 TITLE: Hard-Target-Penetrator End-Game Guidance

OBJECTIVE: Use kinematic global positioning system (GPS) to provide guidance and control for a hard target penetrating missile for location, attitude and impact angle that will maximize target penetration.

DESCRIPTION: The performance of hard-target penetrators is substantially improved by striking the target precisely at the correct point with the correct angle. "Correct angle" means both that the velocity vector is pointing optimally and that the missile body is pointed correctly relative to the velocity vector. In the simple example of a large horizontal slab, the optimum impact would be at the center of the slab, with the velocity vector vertical and zero pitch or yaw angle. Kinematic GPS provides the capability, at low cost, to accurately measure the missile's state, and ensure that this optimum impact is achieved. The purpose of this SBIR topic is to address the following factors needed to use Kinematic GPS in this way:

- Extraction of attitude and velocity information from the GPS signal
- Communication of the kinematic parameters from a base station to the missile, to achieve
- Action, by the missile autopilot, to use the GPS information to achieve the precise impact.

Goals are impact accuracy of 0.1 meter, with velocity vector and attitude accurate to 5 mils The interface to the autopilot should be adaptable widely differing plants, since the technique should be usable in a large supersonic missile (500 pound warhead) or a gun-launched projectile (30 pound warhead), and would also be adaptable to gravity bombs and direct-fire ground and aircraft weapons.

PHASE I: Design the system, including the GPS receiver, communications with the base station, and interface with the autopilot and missile plant. Describing the theory of operation, estimated performance, and technical risks associated with the Phase II development.

PHASE II: Construct and demonstrate hardware for the GPS receiver and base station data link. Demonstrate the guidance method in a simulation.

PHASE III: Transition to potential gun and missile systems, including the Naval Support Fire System (NSFS) projectile program, Low Cost Missile System, and ScramShell gun projectile.

COMMERCIAL POTENTIAL: Accurate state measurements using Kinematic GPS are under development for commercial aviation uses, to provide Category II and Category III precision approach and landing, and attitude measurement to back up gyrocompasses and magnetic compasses. Other applications range from conventional navigation, surveying and map making, to traffic management and agriculture. Accurate azimuth positioning is important to mapping and automatic location of features like road signs, utility poles, and fire hydrants.

N97-117 TITLE: Virtual Laser - Kinematic Global Positioning System (GPS) Terminal Guidance from Spotter to Projectile

OBJECTIVE: Develop the navigation components, algorithms, and communications connectivity to allow a mobile or stationary remote sensor to survey and direct a vehicle to a detected or designated object using Kinematic GPS, including relative speeds and distances.

DESCRIPTION: Military background - In the military application, the remote sensor will be a spotter, the vehicle will be a projectile, and the detected object will be the target. Current semi-active laser designation for bombs, missiles, and projectiles has substantial tactical advantages: The impact point is extremely accurate. Moving targets can be hit. The firing platform need not see the target. Most importantly, the spotter has full control of target aimpoint selection. However, laser designation also has limitations: The laser alerts the target. Successful designation requires visibility from the spotter to the target and then to the projectile. The projectile still must be fired into a highly accurate and small acquisition basket. Finally, the semi-active information does not provide range to the target or time-to-go, reducing our capability to support stand-off fuzing, air bursts, or submunition payloads dispensing. This topic seeks approaches to the use of Kinematic GPS, coupled with accurate measurement of an object's position relative to a remote sensor, to guide a vehicle with laser-like accuracy, but in a more flexible system. The basic concept is to provide the remote sensor with a carrier-phase-sensing GPS receiver and the ability to transmit to the vehicle. The sensor will measure the relative position of the target and transmit that offset, plus its GPS position. The sensor may measure the position of the target in a variety of ways: stationary targets can be measured by triangulation or by placing the GPS receiver at the target object during a mapping effort (in military applications, before the battle--preparing a defensive position, for example). Moving targets can be ranged with a theolodite and laser rangefinder. Airborne spotters can use passive ranging techniques, radar, or lasers. A beamriding approach, where the vehicle moves along the sensor-target line, should be feasible if range information is not obtainable. (Developing these techniques is not part of this topic.) However, the remote sensor will have only a low-quality inertial platform, so the system will have to address angular alignment of the sensor, (that is, the sensor's knowledge of north and vertical). This issue, along with the relative positioning of the vehicle with respect to the sensor and the communication from the sensor to the vehicle are the heart of this topic. Given these capabilities, the goal is to obtain a 1 meter CEP for a target 1 km from the observer.

PHASE I: Develop a design for this system, including algorithms for Kinematic on-the-fly relative positioning, data communication to the incoming projectile/vehicle, and techniques for alignment of the spotter/sensor north and vertical references. A variety of methods may be appropriate since some spotters (for example, aircraft) will be moving, while others may not be able to move (for example, a concealed Marine). Analyze the sources of error and describe the range of conditions under which the system will meet the 1-meter CEP goal. Recommend commercial off-the-shelf components where possible, striving for a system that is easily portable in the field and suitable for use on a small UAV.

PHASE II: Demonstrate the system using brassboard spotter hardware and a surrogate vehicle simulator (portable receiver that will show range and direction to the aimpoint.) Success is shown when the vehicle simulator correctly points to the aimpoint and is within 1 meter of the aimpoint when it reads "at aimpoint"

PHASE III: Incorporate the projectile's portion of the system into the EX-171 Extended Range Guided Munition, and the spotter's portion into the FO/FAC (Forward Observer/Forward Air Controller) equipment.

COMMERCIAL POTENTIAL: The relative navigation and data communications developments are directly applicable to air, sea, and land navigation needs, including precision aircraft landing, smart vehicle/highway systems, oil and gas exploration, agriculture (Ref 3), and environmental surveys. The accurate angular measurements needed are applicable to surveying and map making. This enables improved map making, allowing, for example, a Public Works department to survey its streets and accurately locate every street sign, manhole, pothole, and utility poles, possibly from a moving vehicle.

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2. Schmidt, George, and Roy Setterlund, "Precision Strike Concepts Exploiting Relative GPS Techniques, Navigation: *Journal of* the Institute *of Navigation, Vol.*41, No. 1, Spring 1994, pp 99-112
3. Roberts, Gwyn, et al., A Low-Power Postprocessed DGPS System for Logging theLocations of Sheep on Hill Pastures," Navigation: *Journal of* the *Institute of Navigation, Vol.* 42, No 2, Summer 1995, pp. 327-336.

N97-118 TITLE: Compact Sensors and Guidance for Mid-Caliber Naval Guns

OBJECTIVE: Develop Compact Sensors and Guidance for Rotating, High G, High Speed Bodies

DESCRIPTION: Military Application -- One of the most important applications of mid-caliber (5-inch) Naval guns is in meeting the defensive requirements of the Close-In-Weapon-system (CIWS). The function of the CIWS is to engage and defeat aircraft and cruise missile threats that have avoided the extended range of area defenses. The proposed sensor and guidance system must be small enough to be compatible with the existing nose cavity as used in the Navy's 5/38 and 5/54 projectiles. The compact seeker might use an IR (Infra-Red) detector with central frequency and bandwidth. Cooling for the IR detector could be achieved after launch, possibly through a sudden piston motion during launch setback. Recently developed miniature radar detectors could also be considered as an alternative. Energy for the power system can be obtained from the conversion of a small amount of projectile spin energy converted to electrical energy.

PHASE I: Demonstrate feasibility of a spinning compact detector/sensor suite, such as IR with cooling provided by setback. This should include development the equation of motion of the supporting spinning body, to which is applied an inertial-fixed precessional moment.

PHASE II: Develop a proof-of-concept sensor/seeker that can be gun launched with a transducer/telemetry package. The telemetry should measure rotations and sensor data at 250 meters downrange. Witness cards can be used to determine lateral movement and acceleration. Develop a bread-board of sensor/seeker and guidance system of a type suitable for laboratory demonstration.

PHASE III: Develop a compact sensor/fuze replacement that can be used in a trials program to despin a Naval Projectile. The seeker would acquire a stationary source (such as the Sun if an IR seeker is used); the controller can then input a step to the maneuvering fins of a 5 inch naval projectile.

COMMERCIAL POTENTIAL: The development of inexpensive, compact, high G, IR or radar detector can provide general aviation aircraft or commercial transportation systems a compact, reliable, low cost alternative (or confirming sensor/agent) to existing anti-collision radar systems.

N97-119 TITLE: Thermographic Technology Development for Real-Time Fault Detection

OBJECTIVE: Enable real-time, on-site detection of structural and machinery faults and corrosion in air, surface ship and submarine platforms.

DESCRIPTION: High resolution infrared (IR) thermal imaging technologies have the potential to be a useful tool for detection of faults in machinery and structures. Observation/analysis of thermal patterns (in real time) can provide go/no-go checks and can simplify the diagnosis of machinery and structural members. Thermal imaging can also be used as a post mission analysis tool to determine deterioration of components. Thermal imaging can be combined with other health and usage monitoring technologies to reduce false alarms and improve diagnostic capability for naval surface, subsurface and air assets. Flaws of interest include but are not limited to corrosion of hidden aircraft structures and/or critical components, such as helicopter rotor heads, corrosion or corrosion/erosion (of piping systems) under insulation, and hot spots due to bearing degradation. The net benefit will be enhanced safety and affordability, improved readiness, lower false removals, accurate fault detection, and, conservation of assets.

PHASE I. Establish feasibility to detect typical flaws in machinery and structures using passive infrared thermal imaging. Identify IR- thermal signatures and establish pattern analysis approaches for fault-specific classification.

PHASE II. Develop an operable field-prototype and demonstrate on several types of naval machinery and structures. Acquire a data base for no-fault cconditions and multipal (actual) fault-types. Demonstrate pattern analysis approach for specific fault identification.

PHASE III. Transition to industry for commercialization and extension of fault identification data base.

COMMERCIAL POTENTIAL: Health monitoring in commercial shipping, rail, truck, electric power, heavy construction equipment and commercial air transportation industries.

REFERENCES: OPNAVINST 4790.2, Naval Aviation Maintenance Program

N97-120 TITLE: Intelligent Control Algorithms and PC-Based Software Tool Development for Multiple Effector Control Systems

OBJECTIVE: To use intelligent control techniques, such as fuzzy control and/or neural networks, to develop optimal control algorithms for systems controlled by multiple actuators and effectors in a PC-based software tool for the efficient design or development of algorithms.

DESCRIPTION: The requirements of future systems (such as aircraft, submarines, missiles and spacecraft) are being driven to have improved performance and to perform multiple roles. In order to accomplish these objectives, systems are being designed to be reconfigurable or to have new or additional control effectors. In addition, the resulting control design should be robust to modeling errors, parameter uncertainties and variations, and system noises and errors. As a result, the design of the control system is becoming more complex, especially in developing the optimal control for the integration or blending of various actuators and control effectors. Intelligent control technologies (such as Fuzzy Control and/or Neural Network control) can be utilized to effectively control these types of systems. The successful application of these technologies to other systems and the commercialization of computer chips to perform these types of processes make these technologies appealing. Thus, this task will develop fuzzy and/or neural or other intelligent control algorithms for multiple actuated and controlled systems. In addition, a PC-based software tool is to be developed to allow for a more efficient design process utilizing the intelligent control technologies. The control algorithms are to be robust to modeling errors, parameter uncertainties and variations, and system noises and errors. The algorithms are to be tested in a simulation. The results should be compared to those of systems that utilize traditional or conventional control design approaches. A first version of PC-based software is to be developed, incorporating the traditional and intelligent control methods. This software can either be a stand-alone tool or a toolbox to existing software such as MATLAB. This intelligent control software tool should be flexible and user friendly, to allow for efficient intelligent control design.

PHASE I: Intelligent control algorithms are to be developed for systems with multiple actuators and control effectors.

PHASE II: In Phase II, real time implementations of the control algorithms are to be developed and demonstrated via hardware-in-the loop simulation. Performance improvements should be verified for a few operating conditions, comparing the hardware-in-the-loop results with those found via detailed digital simulation. In Phase II, the software is to be revised and upgraded to make it commercial ready. Beta-testing of the software shall be performed to ensure thoroughness and completeness.

PHASE III: In Phase III, algorithms for actual system operation and implementation are to be demonstrated via hardware-in-the loop simulation and/or actual system test demonstration. Algorithm performance shall be assessed considering the full range of system operating conditions.

COMMERCIAL POTENTIAL: Applications of these approaches for aerospace and transportation industries are beneficial. In particular, these intelligent control techniques could be applied to aircraft, submarines, ships, satellites, missiles, launch vehicles, intelligent transportation vehicles and systems, and other systems with multiple actuators and control devices.

N97-121 TITLE: Biologically Inspired Processor for All-Source Data Association and Fusion

OBJECTIVE: Development and application of biologically inspired data processing methods, techniques, or algorithms, such as artificial neural networks, to underwater vehicles requiring real-time all-source information association and data fusion, with emphasis on the processing of acoustical information.

DESCRIPTION: Future undersea warfare, in the littoral environment, will present much shorter engagement ranges, new threats, environmentally imposed uncertainties, and the higher likelihood of melee encounters. Such factors combine to make the task of data association and fusion for target track estimation and tactical picture generation much more important and difficult than for deeper water. The Navy has adopted, on a science and technology level, a biologic based system as a tracking component of a contact management subsystem within the submarine combat control system. This component, Neurally Inspired Contact Estimation (NICE), uses contact associated data to enhances current capabilities for all-source, real-time data assimilation, fusion, and correlation. This topic seeks a processor capable of associating and combining acoustic and non-acoustic data with individual contact tracks in real-time for input to NICE. The input to this processor is multi-channel data (typically 30 channels) at refresh rates on the order of 0.1 second or less. The output of this processor is contact associated data provided at one second intervals.

PHASE I: Demonstrate the feasibility of a biologic based system for accomplishing contact data association for two or more contacts. The demonstration should incorporate synthesized data from two or more sensors/sources of acoustic/non-acoustic nature.

PHASE II: Full algorithm development and validation with assessment of system performance against synthetic data as well as pre-recorded data from at-sea exercises, encompassing intermittent and uncertain data on several constant motion as well as maneuvering contacts. Deliver software module(s) that can be interfaced with NICE system.

PHASE III: Transition to production as part of the NICE component of the contact management system.

COMMERCIAL POTENTIAL: The techniques, methods, and algorithms will have direct relevance to any application requiring real-time data association, assimilation, fusion, and correlation -- for example: military and Federal Aviation Administration (FAA) aircraft tracking systems, National Oceanic and Atmospheric Administration (NOAA) systems for localizing, tracking, and predicting forest fire flame fronts or fish school populations, as well as Department of Transportation (DOT) systems for localizing, tracking, and direct traffic.

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1. "Neurally Inspired Multi-Source Acoustic Data Fusion" by C.M. DeAngelis, J.L. Harrison, K.J. Ross, and R.W. Green, U.S. Navy Journal of Underwater Acoustics, July 1995.
2. "Neural Network Based Data Fusion System for Source Localization", C.M. DeAngelis and R.W. Green, United States Patent, Number 5,537,511 of 16 July 1996.
3. "Neural Network Based Contact State Estimator", C.M. DeAngelis and R.W. Green, NUWCDIVNPT patent application, Navy Case Number 77289, filed May 1996.
4. "Neural Network Based Three Dimensional Ocean Modeler", C.M. DeAngelis, United States Patent, Number 5,488,589 of 30 January 1996.

N97-122 TITLE: Affordability Measurement and Prediction Technologies

OBJECTIVE: Beginning with theoretical foundations, develop a decision support system for program managers of complex systems.

DESCRIPTION: Affordability of all Navy warfighting and support systems is a major concern in the Department of Defense. From the time a required operational capability is articulated, weapon system affordability must be an issue. The ability to effectively define requirements; generate viable concepts, approaches, and designs; and select the most affordable of these alternatives will depend on the ability to measure the affordability of existing systems and predict the affordability of alternatives. The ultimate acquisition payoff will be the confidence that the most affordable systems will be developed and fielded, and the knowledge of the degree to which expected affordability has been achieved. With this background in mind, ONR is pursuing research and development in the areas of affordability measurement and prediction. For purposes of this research, affordability has been defined as the characteristic of a system that enables it to be procured when it is needed, supported so it remains available as needed, and operated at the level of performance quality desired within the (life cycle) budget allocated to all systems being procured and operated. The goal of this research is to provide high confidence methodologies and tools to assist in making technological decisions that impact the affordability of new and current Naval systems. However, the results of the research may be applied across the Department of Defense as well as in the commercial world.

PHASE I: Determine the theoretical bases for developing executable models that relate to measuring the affordability attributes of complex weapon systems.

PHASE II: Develop mathematical models and measures of effectiveness that characterize the relationships between the parameters that define affordability. Validate the fidelity and robustness of the model by simulating within a pilot DoD program.

PHASE III: Transition these mathematical models into a decision support system for program managers of complex systems.

COMMERCIAL POTENTIAL: The ability to measure and predict the impact of developing technologies on emerging products in the commercial sector could affect consumer economics as well as military system affordability. There is general agreement that dual-use technology development can be a vital affordability enabler for commercial products and for military systems that use those products or variants. So far, the commercial sector has found no effective way to characterize and measure the affordability attributes of existing or emerging technologies or to predict their effect on complex commercial and military systems. Consequently, results of this research could have significant potential for broad commercial application. Several major corporations have expressed interest in pursuing affordability measurement and prediction research.

N97-123 TITLE: Large-Area Infrared-Emissivity-Controlled Surfaces

OBJECTIVE: Develop low cost systems that allow dynamic control of the emissivity of large surfaces.

DESCRIPTION: The infrared energy absorbed, radiated, and reflected from objects is a direct function of the emissivity of the surface of the object. In a number of applications it is highly desirable to be able to control this absorbed, radiated, and reflected energy dynamically over time. This control is necessary to allow for changing environmental conditions. For navy applications, this control must be applied to large areas of surface ships that could extend to thousands of square meters and would be used to control the infrared signature of the ship. Due to the large surface area, the cost per square meter must be commensurate with normal ship construction costs. The method of control must be such that it can be implemented with electronic control signals. Candidate techniques for implementing an emissivity controlled surface system must be developed. The candidate systems shall allow for an electronic control signal to change the emissivity of the surface with a time response in the order of minutes. The candidate systems may be coatings that are applied over existing structures or may be structural components themselves. The candidate systems investigated must have the promise of being low cost when applied to large surface areas.

PHASE I: A theoretical/analytical investigations of and cost projections for surface concepts, as well as construction and testing of laboratory samples, are required to validate the analytical work.

PHASE II: Based on evaluation of candidate systems explored in phase I, develop large scale prototype demonstration articles of the most promising concepts. The demonstration articles shall demonstrate the technical feasibility of the concepts and the ability to manufacture and install large quantities at low cost.

PHASE III: Implement large scale manufacturing capability of emissivity controlled surfaces for military applications.

COMMERCIAL POTENTIAL: Low cost emissivity controlled surfaces have direct application in commercial as well as residential architecture. Such surfaces would be used to control heat absorption and reflection to allow for more efficient energy control of buildings that are subject to variations in climate and weather. These surfaces would also be used on vehicles to reduce air conditioning and heating energy requirements. This would be especially beneficial on all electric vehicles where electrical power for these functions can represent a significant portion of the overall energy requirements of the vehicle.

REFERENCES: Environmental Rersearch Institute of Michigan, "The Infrared Handbook revised edition", 3rd printing, 1989. Access to classified information may be required in phase II.

N97-124 TITLE: Vapor Phase Corrosion Inhibitors

OBJECTIVE: To synthesize and evaluate a new family of environmentally friendly vapor phase corrosion inhibitors for long range protection of naval enclosures with dissimilar materials, such as steel and aluminum.

DESCRIPTION: Vapor phase corrosion inhibitors (VCIs) are chemical compounds, when added in small concentrations to the environment, decrease or control the corrosion of the metal. The VCIs that are currently available in industry can at best control corrosion for a duration of about two years or less depending on the severity of the environment and metal-environment combination. There is a need in the Navy for providing corrosion control of empty steel cells in the future Advanced Double Hull commercial tankers and combatants over five plus years or more. Within steel cells there may be other metallic materials such as aluminum, stainless steel and copper-nickel alloys and therefore, vapor phase corrosion inhibitors should offer protection to multi-metals in steel cells enclosing electronic, pipeline, and other systems combining dissimilar materials.

PHASE I: Develop a family of new vapor phase corrosion inhibitors that are non-toxic and environmentally friendly, and evaluate their corrosion controlling efficiencies using common naval materials such as steel, aluminum and copper-nickel alloys in marine environments. The evaluations can be done using state-of-the art corrosion control methodologies in the laboratory.

PHASE II: Corrosion controlling efficiencies of VCIs can be tested and monitored in simulated systems that are exposed to natural marine environment.

PHASE III: Demonstrate the performance of successful vapor phase inhibitors selected from Phase I studies by monitoring the corrosion controlling efficiencies of selected shipboard systems (e.g., gun mounts and inverter cabinets) installed on AEGIS cruisers or other surface platforms representative of current and new ship classes.

COMMERCIAL POTENTIAL: The ship building industry can use the developed vapor phase corrosion inhibitors for protecting the steel cells on the Advance Double Hull commercial tankers from corrosion and to protect steel stock pilings from corrosion. These can also be used in oil and gas industry to protect the rigging tools from corrosion. Vapor phase corrosion inhibitors can be used to protect large civilian and military equipment during lay away and moth balling.

REFERENCES:
1. G. E. Fodor, in "Reviews on Corrosion Inhibitor Science and Technology," A. Raman and P. Labine, eds. (Houston, TX: NACE, 1993), p. II-16-1.
2. B. A. Miksic, in "Reviews on Corrosion Inhibitor Science and Technology," A. Raman and P. Labine, eds. (Houston, TX:NACE, 1993), p. II-17-1.
3. K. L. Vasanth, "Corrosion Inhibition in Naval Vessels," CORROSION/96 (Houston,TX:NACE 1996), paper # 233.

N97-125 TITLE: 3D Virtual Workbench

OBJECTIVE: Enable decision makers and engineering designers to visualize and interact in 3D with complex, computer-generated geometrical scenes ranging from 3D terrain populated with objects to large scale design systems.

DESCRIPTION: The Virtual Workbench paradigm for visualizing and interacting with 3D, computer-generated data has been shown to offer revolutionary capabilities. Individuals or groups utilize these displays to develop concepts and designs and to better understand multidimensional data sets. This effort would overcome limitations in the first generation of Virtual Workbenches; the most constraining of which is that multiple users see the scene only from the perspective of a single group leader who must perform all interactions presently.

PHASE I: Develop a Virtual Workbench in which two users observe different views of the scene. This system should allow each viewer to see images tailored to individual head movements and to each user's tasks using stereographic shuttered glasses at refresh rates high enough to eliminate flicker.

PHASE II: Develop a Virtual Workbench that enables four viewers to see individual images at flicker-free data rates and improve the resolution of the display over that provided by current projector technology. Development will include human factors analysis and performance assessment of the improved Workbench.

PHASE III: Produce virtual workbenchs for shipboard and/or headquarters use which are compact and effective in design, command and control, medicine, scientific analysis, and other relevant applications.

COMMERCIAL POTENTIAL: The system is applicable to any work environment requiring interaction with 3D, computer-generated images. Engineering design and medicine are two specific domains that would utilize this technology.

REFERENCE: Wolfgang Kruger, et al., "The Responsive Workbench", Computer, Vol. 28, No.7, July 1997.

N97-126 TITLE: Structural Health Monitoring Using Fiber-Optic Sensing

OBJECTIVE: Allow for the permanent installation and continuous operation of fiber-optic (structural) sensors on Navy ships so that structural health assessment may become an integral part of the entire ship sensor system package.

DESCRIPTION: The direct application of fiber optic technologies to the sensing and communication of structural responses is the primary objective. However, fiber optic sensors may also be used to measure a wide array of other important parameters, such as temperature or contaminant levels. All of these sensing technologies have a place on board modern Navy ships. Fiber optics in general is especially useful in wet, dirty, and electrically noisy environments. Fiber optic techniques can also be used to monitor flow, level, temperature, and vibration. Perimeter sensing and security have also been enhanced by the use of fiber optic and other light technologies (laser). Fiber optics, in general, offers a method of eliminating many mechanical sensors, electrically and magnetically sensitive electronics and wiring, and a number of other problems associated with intrusive sensing or sensing in difficult areas. The long term payoff of applying these technologies to Navy ships could be enormous, both financially and technologically. This structural health assessment system must be capable of interfacing with other automated systems currently being developed.

PHASE I: Demonstrate accuracy and applicability of fiber optic structural sensors during static or slowly varying structural tests.

PHASE II: Develop and/or assemble fiber optic based data acquisition system for data transmission and recording.

PHASE III: Develop fiber optic based data acquisition system utilizing fiber optic sensors and communications on board a Navy ship. Demonstrate system capability during at sea operations.

COMMERCIAL POTENTIAL: The hardware and/or complete system developed under this program can directly be used for commercial shipping (especially freighters and oil tankers), offshore structures, and land based civil engineering structures, such as bridges. There is also application for structures located in earthquake zones.

REFERENCES:
1. "Progress Towards the Development of Practical Fiber Bragg Grating Instrumentation Systems," Kersey, A.D. et.al. , Fiber Optic Smart Structures Section, Naval Research Laboratory, Washington, D.C. 20375-5000, September 1996.
2. "Conceptual Plan for a Real Time Ship Monitoring and Structural Assessment System," Kuny, J., Lewis, R., Dianora, M., Intelligent Ships Symposium II, American Society of Naval Engineers, Delaware Valley Section, 25 November 1996.

MARINE CORPS SYSTEMS COMMAND

N97-127 TITLE: AAAV Surf Zone Simulation Model

OBJECTIVE: To develop a physics-based, time-domain simulation model of the littoral environment suitable for use by the Advanced Amphibious Assault Vehicle (AAAV) program.

DESCRIPTION: A high fidelity simulation model of the littoral environment is needed to support verification of the AAAV design; to determine the performance impact of any modifications to the AAAV hull design proposed in the future; to facilitate development of training simulators for the AAAV and AAV; and to facilitate upgrading of the Landing Craft Air Cushion (LCAC) Full Mission Trainer. The model must be physics-based, time-domain, and of sufficient fidelity to support simulation of the handling and propulsion response of the AAAV to surging, spilling, and plunging surf effects as a function of sea state, sandbars and bottom characteristics, beach slope, tides, refraction, current, and wind. Boundary conditions are also needed to allow a seamless interface with existing dynamic open ocean simulation models. The model shall support simulation of AAAV operation during both planing and displacement states, and during transitions from one state to the other. The developed model shall be amenable to real-time computation, and shall not be unique to any specific computer or image generation hardware. The littoral model shall make use of best available cartographic/ geographic data such as the new Littoral Warfare Data (LWD) product from the Defense Mapping Agency.

PHASE I: Examine existing physics-based, time-domain models of the surf zone, and identify any deficiencies with respect to their capability to support simulation of the full dynamic response of the AAAV in the littoral environment. Determine the tests and analyses which need to be performed, and the data to be collected. Select a source or a methodology for developing the 3-D synthetic models of the AAAV and littoral environment features. Establish a process to validate the developed system.

PHASE II: Collect and analyze any supplemental wave modeling data identified in Phase I. Refine/extend/synthesize the AAAV physics-based surf model. Acquire or develop the 3-D synthetic representations of the AAAV and littoral features. Develop the AAAV vehicle dynamics model. All test data taken under the AAAV contract will be provided as GFI. Integrate the surf zone wave model and synthetic littoral environment with the AAAV vehicle dynamics model. Validate the complete system. Verify that the simulated AAAV response matches empirical performance data. Identify inherent limitations and inaccuracies of the model.

PHASE III: The validated models and software will be made available to the AAAV, AAV and LCAC simulator procurements, and made available to industry for development of commercial applications.

COMMERCIAL POTENTIAL: The proposed technology development has very broad application and unique potential for commercial simulations associated with dynamic surf.

N97-130 TITLE: Commercial Digital Camera Environmental Protection

OBJECTIVE: To provide low cost means of protecting a commercial, digital camera from harsh environments while allowing the camera to function.

DESCRIPTION: The goal of this SBIR is to produce a system which allows various lenses up to 500mm, in the environmental and physical conditions encountered by a Marine Expeditionary Force Reconnaissance Team (MEFRT). These include rain, blowing rain, salt fog, salt spray, blowing sand and dust, submersion to 32 feet and repeated shocks associated with man-packing and employment in the field for extended periods. Presently the MEFRT uses a Kodak DCS 420 digital camera but solution should be as generic as possible.

PHASE I: Show feasibility, System Design, Drawings, Specification, and Prototype. Cost estimate for Phase II.

PHASE II: Demonstrate system under severe environmental and employment conditions. Test report, design changes as needed, final System Configuration, Specification, nine pre-production items.

PHASE III: Product will become a production part of the Manpack Secondary Imagery Dissemination System (SIDS) and potentially the Tactical Photography (Tac-Photo) system. The small business will retain rights to the system and follow on designs, which it can market to the commercial sector for similar applications.

COMMERCIAL POTENTIAL: Numerous industries employ audio-visual equipment in adverse environmental conditions. Digital camera present numerous advantages over film cameras, yet environmental protection systems are currently unavailable for digital cameras. Emerging applications to law enforcement, surveying, environmental research, and exploration are easily envisioned.

REFERENCES: Manpack Secondary Imagery Dissemination System (SIDS) System Specification

N97-131 TITLE: Wide-Field-Of-View Anamorphic Lens

OBJECTIVE: Design, fabricate and evaluate an anamorphic optical system for an imaging infrared camera which maximizes viewing angle along a preferred axis (i.e., horizontal or vertical), and diminishes viewing angle along the orthogonal axis while maintaining an equal projected area per pixel.

DESCRIPTION: Video produced from imaging systems generally conform to an industry standard height to width aspect ratio, which allows recording, playback, and data analysis on generic equipment. Application specific aspect ratios using COTS hardware, can be implemented using an anamorphic optic which projects the distended scene on to the camera's detector array.

PHASE I: Perform theoretical design analysis of optical components and implement design for best image quality. Fabricate lens. Goal is 120° to 150° x 15°.

PHASE II: Implement engineering upgrade for isothermal focus from -20° C to +40° C without operator adjustment. Perform cost vs performance analysis for compact, low cost, lightweight designs, including replicated optics. Deliver Phase I isothermal design and cost optimized Phase II isothermal design hardware. PHASE III: Adapt optical design to alternative infrared and visible imaging systems.

COMMERCIAL POTENTIAL: In applications such as security, surveillance, and search and rescue, there is a long axis (e.g., a horizon, tall building, long street) which contains the information of interest and sky and foreground fractions (typified by conventional imaging systems) are undesirable. The optical design and lens elements resulting from this effort could be readily adapted to such purposes.

NAVAL AVIATION TEAM

N97-132 TITLE: Utilization of Fractal Based Models for Acoustic Signal Processing

OBJECTIVE: Develop and demonstrate the use of fractal based models for signal processing of non traditional signals with applications to detection and classification of one and two dimensional signals.

DESCRIPTION: A significant portion of conventional signal processing is based on the use and application of the Fast Fourier Transform (FFT) for those cases where the signal of interest is either narrow-band or wide-band in nature. Often, signal processing techniques are applied to the ubiquitous tasks of detection and classification; as such, the use of the FFT is connected to the signal energy content in the frequency domain. While the use of frequency localized signal energy is robust and practical it ignores any coherent or signal structure information contained in the measured data. Therefore, to exceed the detection and classification performance characteristics of conventional energy computations new processing techniques must be developed which exploit the signal's structure and coherent information beyond its energy content. One avenue of approach toward this end is to develop detection and classification processing based on the utilization of signal models.

This effort will focus on the use of fractal based models for both the one-dimensional (e.g., time-series) and two-dimensional (e.g., images) signal cases. Fractal models have enjoyed great success for modeling one- and two-dimensional signals with iterated function systems. In particular this is true for the signal compression problem. For this effort the contractor must first demonstrate which aspects of the fractal model are pertinent to the detection and classification problem and then develop an appropriate framework. Subsequently, the contractor must process data of interest to demonstrate the efficacy of the proposed methods. A conventional energy based detector will be used as a benchmark to evaluate the benefits of the new fractal techniques. For the one dimensional signal case receiver operating characteristic (ROC), curves will be generated and plotted on the same axes as the energy detector ROC curve so performance can be quickly evaluated.

PHASE I: Develop, describe, and implement the fractal techniques and compare their performance with classical methods of detection and classification. These methods must show significant improvements over present methods to go on to phase II.

PHASE II: Refine algorithms and perform extensive testing on real data. New algorithms must be rendered computationally efficient for aircraft usage. Preliminary plans will be made to implement the improved techniques on prototype systems/ platforms.

PHASE III: Install software algorithms in aircraft testbed for operational testing and evaluate algorithm performances. Subsequently, install algorithms on Beartrap aircraft for inflight testing.

COMMERCIAL POTENTIAL: As the techniques and methodologies developed herein are general in nature they may be applied to other signal processing problems. Other areas of application are: medical imaging, storage, and restoration; rapid image storage and retrieval on the information super highway; satellite/global terrain surveying; sea mapping; forward battle field information gathering; and other remote sensing, storage, and transmission systems.

N97-133 TITLE: COTS Real Time Unified Avionics Interconnect

OBJECTIVE: Adapt the emerging widely used COTS Serial Express interconnect protocol for use as a Unified Avionics Interconnect supporting optical backplanes and networks. Develop a prototype chip.

DESCRIPTION: Current military aircraft avionics use multiple interconnect types. For example, the F-22 uses five distinct avionics interconnects--three types in the backplane and two types between racks and sensors. In addition, both electrical and optical instantiations are used This multiplicity is expensive and causes performance degradation in bridging between interconnect types. Moreover, the interconnects are inadequate for emerging digital receiver technology (which will dramatically reduce avionics costs). The ideal interconnect would be a single unified protocol upwardly compatible with VME--preferably optically instantiated to provide high speed and low noise. Commercial interconnect technology (such as the Scalable Coherent Interface and Serial Express) is now available which runs at the necessary speed (8 Gbits/sec/link), achieves the low latency (through byte addressing) necessary for backplane usage, and supports optical backplane and network instantiations. However, none of the newly developed interconnects provide the features needed for real time (military and commercial) usage. The features needed include deterministic scheduling, fault tolerance, and (for the military) security. This effort will extend the commercial Serial Express interconnect protocol for high performance real time use.

PHASE I: Develop and simulate Serial Express high performance real time protocol enhancements including determinism, fault tolerance, and security. Perform the work in conjunction with, and with input from, the Serial Express industry working group which includes Sun, Cray (SGI), Intel, Apple, Lockheed, Northrop, Hughes, and others. Show VME P2 connector compatibility.

PHASE II: Design and prototype a real time Serial Express chip and standard cell design.

PHASE III. Transition the real time Serial Express chip and standard cell design to a commercial chip fabricator/ vendor (such as LSI Logic) for production and marketing.

COMMERCIAL POTENTIAL: Intel and Sun plan to use Serial Express in every personal computer/ workstation they build (millions). Several commercial computer companies are interested in extending their systems for real time usage. Two, in particular (Sun and Cray) want to extend Serial Express for high performance real time usage and would provide commercial transition.

REFERENCES:

1. IEEE 1596-1996 Scalable Coherent Interface
2. IEEE 1394.2 Serial Express (Draft)

N97-134 TITLE: Low-cost High-speed Optical Links for Advanced Avionics Data Networks

OBJECTIVE: To reduce the cost and increase the performance and reliability of high-performance interconnects used in advanced avionics data networks.

DESCRIPTION: Next generation avionics systems will require an order of magnitude increase in processing and networking capacity. In order to provide this capacity and at the same time reduce system component and development costs, a greater reliance is being placed on commercial off-the-shelf (COTS) protocols and components. One of the major impediments to the development of high-performance COTS-based networks is the cost of the networking components. This program is aimed at the development of a low-cost, high-performance fiber optic link for digital networks. The link should provide data microrates in the range of 4-8

Gb/s with latencies of less than 10 seconds at a unit cost of less than $1500 in quantity. The link should support a commercial high-performance protocol. In addition, a ruggedized version of the link should be capable of operating over the military temperature range.

PHASE I: Demonstrate feasibility of the interconnect by modeling and simulation of performance, cost, size, weight, and power of the link. Evaluate the temperature performance of the link. Evaluate and select COTS-based protocol chip.

PHASE II: Develop and demonstrate link prototype. Evaluate prototype for throughput, latency, size, weight, power dissipation, and performance over the military temperature range. The results of this evaluation should be used to verify Phase I modeling and simulation results and to estimate the unit cost of a commercial module.

PHASE III: In conjunction with a commercial optical module fabrication house, develop a low-cost integrated module suitable for both commercial and military applications.

COMMERCIAL POTENTIAL: The high cost of high-performance interconnects currently available represents a major limitation to their introduction into commercial computer networks. The development of low-cost high-speed networking components would represent a breakthrough in the field of commercial computer networks that would bring the benefits of high-end workstation clusters into the realm of economical desktop computing.

REFERENCES:

1. IEEE 1596-1996 Scalable Coherent Interface
2. IEEE 1394.2 Serial Express (Draft)
3. Joint Advanced Strike Technology Program, "Avionics Architecture Definition," Version 1.0, September 23, 1994.

N97-135 TITLE: Advanced Ship Motion Forecasting for Expanded Aviation Operations

OBJECTIVE: To develop a ship motion forecasting system for the purpose of allowing significant improvements in aircraft landing guidance, recovery and launch operations. This system will augment current and future aircraft launch and recovery systems on all seabased aviation platforms. It will increase the precision and safety of aircraft operations, especially in higher sea states.

DESCRIPTION: Aircraft/Ship Dynamic Interface is the interrelationships of an aircraftÕs dynamics and a shipÕs dynamics when the two are in close proximity to each other. Aircraft include both conventional take-off and landing (CTOL) and vertical take-off and landing (VTOL), both rotary wing and fixed wing, aircraft families. Ships include aircraft carriers (CV/CVN), large deck amphibious assault ships (LHA/LHD) and air capable ships. Ship motion is a major contributor to the Aircraft/Ship Dynamic Interface problem. Ship motion is a critical operational parameter in the safe conduct of aircraft operations, which include; launch/take-off, approach, recovery/landing, rotor engage/disengage, inflight refueling, vertical replenishment, etc. Ocean inputs plus wind inputs act on the ship resulting in ship motion. Ocean inputs may include both surface and subsurface effects. Past attempts at developing ship motion forecasting schemes and lull predictors, primarily to support the AV-8B and other air vehicles with limited hover endurance, were unsuccessful. The technical challenge in addressing this problem lies in the fact that it is extremely difficult to determine ship response to energy inputs from the sea and wind. For this system to be useful it must be capable of accurately forecasting ship motion a minimum of 10 seconds in advance and must be robust enough to accommodate any aviation ship. It is desirable that the concept would use data from existing shipboard instruments.

PHASE I: Conduct a six month study which would consist of the following: a) an analysis of past work in this area; b) a determination and assessment of the relevant data that is currently available on Navy aviation ships; c) collecting and analyzing existing detailed data sets with respect to various forcing functions and ship response; and d) development of an advanced concept for forecasting ship motion a minimum of 10 seconds in advance. This concept shall include a performance model.

PHASE II: Develop a detailed design of the Ship Motion Forecasting System. The contractor shall also provide a breadboard system and demonstrate its performance using detailed real data sets. The system outputs shall be compatible with the current generation of Shipboard Visual Landing Aid Systems.

PHASE III: The contractor shall take the proven Ship Motion Forecasting System, harden it for shipboard use and conduct a demonstration and evaluation of the system onboard a Navy ship at sea. This demonstration will include providing accurate inputs to augment the Shipboard Visual Landing Aid System. This will be the transition of this system into NAVAIRSYSCOM PMA-251's Shipboard Aviation Systems Development Program.

COMMERCIAL POTENTIAL: The stated objective of this topic is to develop a ship motion forecasting system. This is one of several applications of this concept. Under this concept, the system would collect necessary sea/ship/platform data (be it from sensors currently available on the platform or utilizing additional sensors) and accurately forecast sea conditions thus allowing appropriate actions to be taken. This information is extremely valuable to a variety of ships including: passenger and auto ferries, oil tankers, cargo vessels, commercial pleasure cruise vessels, commercial fishing trawlers, seismic exploration and ocean mapping vessels and ocean cable laying ships. This information is also valuable to other platforms, such as offshore drilling rigs and weather forecasting and shoreline erosion research platforms.

For ship type platforms this SBIR concept will:

a) assist in plotting the shipÕs course to avoid undesirable sea conditions and corresponding ship response

b) assist in stabilizing the ship against severe motion during higher sea state conditions to ensure the survivability of the ship and to protect the shipÕs cargo which could include: passengers, automobiles, fuel, containers and other types of cargo

c) assist in the operation of rotary wing air vehicles from these platforms which would include: approach, landing, take-off, in-hover refueling and vertical replenishment

d) assist during ship-to-ship and ship-to-platform replenishment operations whether it be transferring supplies, cargo or personnel

e) assist during close maneuvering and or docking operations to avoid serious ship-to-ship and ship-to-dock impacts due to sea conditions

For more stationary type platforms this SBIR concept will:

a) assist in preserving the integrity and safety of the various platforms

b) provide a measurement and collection capability for acquiring sea impact data to be used in design of future platforms and for shoreline erosion studies

c) assist in aiding the operations decisions and load optimization for off-shore oil drilling platforms

N97-136 TITLE: Advanced Targeting through Decision Aids

OBJECTIVE: Perform exploratory research to identify innovative information processing architectures that can advance current interactive, computerized decision aids into learning and evolving decision making systems in support of Reconnaissance, Surveillance, and Target Acquisition missions.

DESCRIPTION: The dynamic nature of the battlefield requires near-real-time information to maintain the commander's awareness of the situation. Computer-based decision aids support portions of situational awareness by providing target movement prediction, threat analysis, vehicle modeling, imagery display and analysis, etc. Each of these decision aids requires a trained and experienced operator to maximize the utility of the decision aid. The appropriate level of training and experience is not always possible in preparation for, or during, an armed conflict. Further, each decision aid may yield an output product that is inconsistent with the products of the other decision aids. This inconsistency requires iterations in the planning cycle and/or yields conflicting mission data. A significant improvement in operational effectiveness would be provided by an information processing architecture with the following minimum capabilities: (1) Provide a framework which enables existing decision aids to be plugged in to a single system, (2) Standardize the assumptions and find a common baseline for the output of each decision aid, (3) Provide a software agent to watch experienced operators use each decision aid and learn appropriate actions for a variety of situations, for both the individual decision aids and the planning process as a whole, (4) Watch less-experienced operators and provide immediate feedback on their actions and inactions for the current situation, and (5) Perform in a completely autonomous mode whereby the software is able to make a decision based on inputs to the various decision aids and the current situation (e.g., day four of a conflict, specific regional tendencies, night operations, etc.). Artificial intelligence techniques have not shown sufficient maturity to be used as decision makers or decision quality control in armed conflict. However, recent biologically inspired developments in the field of computer science have shown preliminary advances in learning and evolving, including genetic algorithms, artificial life, cellular automata, and a variety of hybrid technologies. The focus of the Phase I effort is to define an "intelligent" architecture that addresses the learning, teaching, and evolving nature of an automated decision making system. The baseline for this effort is the mobile and relocatable target search problem. The system should be able to perform in near real-time. A prototype implementation should be developed in C or C++ and should be able to run on equipment consistent with Navy combatant computer architectures.

PHASE I: Conduct an analysis of the operator's planning process and perform exploratory research of candidate technologies for developing an information processing architecture for an advanced targeting system. Demonstrate results as part of a prototype implementation.

PHASE II: Expand the prototype system to demonstrate the architecture; the system should be able to learn from experienced operators (at both the individual decision aid and the planning process levels), and provide immediate feedback on the actions and inactions of less-experienced operators.

PHASE III: Expand the Phase II prototype into an operational system that standardizes the assumptions and provides consistent output for each decision aid, and is able to perform in a completely autonomous decision making mode.

COMMERCIAL POTENTIAL: Training systems, Search and rescue operations, counter-drug operations, police surveillance operations.

REFERENCES:

1. Navy combatant computer architecture. (http://www.nswc.navy.mil/TAC-4/)
2. Common Operating Environment. (http://spider.osfl.disa.mil/dii/)
3. Holland, J. H. "Adaptations in Natural and Artificial Systems", MIT Press, 1992.
4. WWW.NSWC.NAVY.MIL/TD/AC/SBIR

N97-138 TITLE: Interference Mitigation in Night Vision Goggle (NVG) Systems

OBJECTIVE: Develop a technique or set of techniques to mitigate interference effects in NVGs.

DESCRIPTION: Current GEN III NVG systems provide a tremendous advantage to naval aircrew during covert night operations. However, these systems are susceptible to serious performance degradations from external interference sources. Examples of interference effects include blooming due to bright objects in the field of view, dazzling/blinding due to intentional/unintentional laser interference, and undesired Auto-Brilliance Control initiation due to one or more high energy source(s) leading to decreased gain and loss of image contrast. In some instances the performance degradation caused by the interference can prevent the successful completion of a mission. To combat these possibilities, the Navy is interested in developing a compact, lightweight device to be used with existing GEN III NVG's that will mitigate the susceptibility to interference. Preference will be given to solutions that can be retrofit into existing NVG systems, through alternative system designs will not be ruled out if they are shown to reduce the size and weight of the end product.

PHASE I: Design and analyze an optical device to mitigate interference effects in GEN III NVG. Build and test a proof-of concept device demonstrating the critical technologies. Make specific recommendations regarding which NVG systems are suitable for use with the device. Modeling and/or experimental data will be required to identify any performance degradation due to installation of the device into an NVG system.

PHASE II: Using modeling and hardware from Phase I, and additional hardware as necessary, evaluate the combined NVG/interference mitigation system to identify techniques to optimize performance. Build a first-generation device and demonstrate/evaluate its operation/performance with a GEN III NVG system.

PHASE III: Phase III will include both military and commercial applications for NVG interference mitigation. Based on the results of the Phase II effort, develop production representative interference mitigation devices along with manufacturer test data for verification/validation by the appropriate military and commercial evaluation organizations. Primary military applications include NVG improvements for F/A-18, AV-8B, and F-14 aircraft for use in night operations. Primary commercial applications include police and private aircraft surveillance activities.

COMMERCIAL POTENTIAL: Night Vision Devices are currently used by law enforcement agencies, news agencies, boaters, and others. This commercial demand is increasing rapidly and the requirement to mitigate interference sources will grow as the utilization increases. The same technology used to mitigate interference in Navy NVG will be equally effective in mitigating interference in commercial NVGs. The ability to expand the technology into various market needs will provide low cost solutions to overall development and production.

N97-139 TITLE: Advanced signal processing and Display Concepts for airborne Active ASW Systems

OBJECTIVE: Use advanced signal processing and display techniques to enhance performance of future airborne active acoustic ASW systems in high clutter environments.

DESCRIPTION: Advanced low frequency coherent active systems will present the acoustic operator with excessive workload if traditional active acoustic signal processing and display methods are used. Planned improvements in sensors and avionics will allow for the use of advanced waveforms, signal processing, display, and data fusion. System performance will depend upon the application of such advanced concepts to enhance detection performance and reduce false alerts to an acceptable level, especially in the adverse environments of projected areas of operation. This SBIR effort will address the best use of sensor improvements to meet the required airborne ASW system performance.

PHASE I: Provide innovative signal processing, classification and display concepts which best capitalize on the advanced active sensors and avionics improvements. The concepts must demonstrate sufficient performance metrics of target detection and false alarm probabilities to add value to the planned airborne ASW systems, as well as feasible system implementation.

PHASE II: Develop, test and operationally demonstrate a working prototype of the techniques investigated under the Phase I SBIR effort, using actual Government furnished input data. The prototype system must be consistent with transition of the concepts to fleet systems.

PHASE III: Implement the systems concepts and signal processing algorithms in a fleet ASW platform configuration.

COMMERCIAL POTENTIAL: The advanced signal and data processing techniques developed under this task can be applied to commercial sonar systems.

NAVAL FACILITIES ENGINEERING CENTER

N97-140 TITLE: Rapid Cargo Throughput for Sea Based Logistics

OBJECTIVE: Develop logistics technologies to enable the Marine Corps to perform SEA BASED LOGISTICS from various floating platform configurations. Sea based logistics is the performance of essential combat service support (CSS) functions from a floating logistics platform.

DESCRIPTION: Winding down of the Cold War led the Navy and Marine Corps to change their operational doctrine from seeking worldwide, blue-water superiority to power projection in littoral areas. For its part in this new strategy, the Marine Corps developed a new doctrine referred to as Operational Maneuver from the Sea (OMFTS), which stresses the application of firepower and maneuver warfare. Much of the emphasis on OMFTS has been on high technology in the areas of firepower and maneuver, overshadowing the vital elements of combat service support (CSS). Since OMFTS changes the way combat power is deployed, traditional amphibious logistics ashore will not meet the unique logistics demands of OMFTS. aS based logistics (SBL) has been proposed as the solution to provide combat service for OMFTS operations. Logistics support for the Marine Corps fighting forces ashore, the Marine Air-Ground Task Force (MAGTF), is called Combat Service Support (CSS). CSS provides the essential capabilities, functions, activities, and tasks necessary to sustain all elements of operating forces in theater at all levels of warfare. Traditionally, CSS has been performed from a base established ashore. The most prominent feature of SBL is that it supports combat units directly from ships or other floating platforms offshore instead of building a logistic infrastructure ashore. As envisioned at present airlift in various forms (helicopter, VSTOL, etc.) will be the dominant transport mode of SBL.

It is generally held that the application of SBL to provide the essential support for OMFTS is possible only in limited situations today. SBL is constrained by equipment limitations, traditional methods of logistics delivery and packaging, and configuration and outfitting of existing potential logistics bases (mainly ships). Today's amphibious shipping is configured for "combat loading" in which the ship's cargo is fully unloaded via the "last in first out" method. The success or failure of an OMFTS mission is determined by how well supplies, equipment, and personnel move through the logistic system.

It is the intent of this exploratory development effort to identify new technologies, equipment, and procedures that can contribute toward a SBL capability necessary to support OMFTS at all force levels and over the range of Marine Corps missions. Assume that a Seabase will consist of a set of amphibious ships augmented by merchant ships of the container break/bulk or Roll On/Roll Off variety. The problem to be addressed is the movement of cargo/containers from a confined area to the beach in a rapid manner.

Proposals may be for complete new cargo handling systems to a single component that has significant potential to enhance today's capability to perform sea based logistics. The intent is to award one contract for this topic; however, additional contracts may be awarded based on the merit of proposals received.

PHASE I: Develop a concept and preliminary design for the proposed system/component. A wide range of proposals will be considered for award in Phase I of this topic. Cargo handling equipment/methods, selective cargo offload, ISO container unstuffing/stuffing methods, and airlift deployment methods aboard ships/platforms are of particular interest.

PHASE II: Validate the proposed design. Advance the preliminary design to the stage that a prototype can be fabricated. Demonstrate the capability of the design by testing the prototype in a mockup or in an available shipboard environment.

PHASE III: Complete the design package and prepare a performance type specification for use in commercial and military applications. The new system/component/procedure will be considered for use in the next generation sea base ship/platform.

COMMERCIAL POTENTIAL: The system or component(s) has potential for use in all inter-modal facets of the cargo handling industry. Shipboard cargo handling and management systems have potential to improve the way commercial maritime cargo operates today. Methods to unstuff/stuff ISO containers could have immediate commercial application throughout the cargo handling industry.

REFERENCES:
1. Navy Science and Technology Round Table for 1996
2. Marine Corps Expeditionary Warfare Science and Technology Round Table for 1996.
3. Committee on "The Navy and Marine Corps in Regional Conflict in the 21 st Century " by the Naval Studies Board.
4. "Operational Maneuver From the Sea," Marine Corps Gazette, June 1996.

N97-141 TITLE: Relocatable Crane Technology for Use on Floating Platforms

OBJECTIVE: Develop the technology or mechanisms needed that will allow relocatable cranes to be used on floating platforms subject to wave-induced motions in open ocean conditions.

DESCRIPTION: Existing technology for relocatable cranes, such as that used to move and secure rail-mounted portal-type cranes, is insufficient to withstand the dynamic loads imposed by the wave-induced motions of floating platforms. The development of suitable technology or mechanisms that would permit rail-mounted cranes to be used on floating platforms exposed to open-ocean conditions, or the development of a new concept for relocatable cranes that would function under these conditions is sought.

PHASE I: Develop a concept for either a mechanism that will permit the use of rail-mounted cranes on floating platforms exposed to open ocean conditions, or a concept for a new type of relocatable crane that will function under these conditions. Complete a feasibility assessment of the concept, addressing all environmental and operational load conditions.

PHASE II: Develop a conceptual design for the concept. Demonstrate the ability of the concept to meet the environmental and operational load requirements through model testing or full-scale subsystem or sub-component testing.

PHASE III: Develop a complete preliminary design and specification for the concept suitable for prototype fabrication.

COMMERCIAL POTENTIAL: This technology or mechanism would be useful to the offshore construction and sealift industries. The development of a suitable concept could lead to more versatile barge cranes used in offshore construction practice. The incorporation of this technology into commercial sealift ships could provide a greatly enhanced self-sustainment capability, allowing ship cranes to access a higher percentage, if not all, of their shipboard cargo spaces and allow the direct transfer to shore-based facilities. This would speed both offloading and loading operations.

N97-142 TITLE: Integrated Control of A Powered Causeway Ferry

OBJECTIVE: Develop and demonstrate a commercially viable integrated, intuitive operator friendly controller that will increase maneuverability of causeway ferries while reducing the need for highly skilled operators. The system shall simultaneously control from two to four fully azimuthing thrusters. It is also desirable that the control system be adaptable to a land-based simulator (trainer).

DESCRIPTION: The existing Navy causeway ferries, which are 5-ft deep by 21-ft wide and vary in length from 90- to 360-ft in 90-ft increments, are not fully capable of maneuvering alongside ships and piers during a Logistics Over The Shore (LOTS) operation in higher sea states. This deficiency is primarily due to the fact that only two thrusters are available and both are located in the stern of the causeway ferry. Each thruster currently has separate controls for engine rpm and nozzle direction. The Navy is currently developing more capable causeway ferries that will be able to operate in sea state 3(SS3). This system makes use of larger causeway sections, each 8-ft deep by 24-ft wide by 120-ft long, that are assembled into ferries 120-, 240- and 360-ft long. To provide better maneuver capability, bow thrusters can be used. For a new causeway ferry that utilizes two bow and two stern thrusters, eight controls (engine rpm and nozzle direction for each thruster) would be required. Because this number of controls is too many for Navy personnel with limited training and experience to handle, a simplified control system is required. To meet this requirement, the Navy wishes to develop an intuitive joy stick control system. The system would control multiple, fully azimuthing waterjets capable of producing approximately 6,000 pounds thrust each. Individual as well as simultaneous vector and rotational control of the causeway ferry is required. Net thrust during these maneuvers should be optimized for maximum efficiency. The control system would also have to compensate for thruster causalities. The end product of this development should result in a control system that allows either loaded or unloaded causeway ferries to be safely maneuvered underway as well as during approach and moor operations alongside either a ship or pier to receive and/or discharge cargo.

PHASE I: Develop a system design for a integrated, intuitive control system for causeway ferries. This system must be adaptive, operator friendly , i.e. easy to use with control logic that addresses use of a varying number of thrusters, and the varying length and displacement of causeway ferry configurations. The system design should also consider the option of being upgraded to a dynamic positioning system at a future date.

PHASE II: Validate system design of a integrated, intuitive controller. Develop integrated, intuitive control hardware and logic (software). Demonstrate aboard a Government provided causeway ferry. Document demonstration results and address system design deficiencies.

PHASE III: Prepare system performance specification for use in commercial and military applications. Results of successful development will be considered in new causeway ferry acquisition or retrofitted to existing hardware assets.

COMMERCIAL POTENTIAL: This system provides a new concept to the marine industry that could be used aboard large barge trains with multiple tugs to integrate and optimize their control. This system could meet the stringent maneuvering environment of river navigation for large barge trains.

N97-143 TITLE: Multiple Access RF Communication Protocol

OBJECTIVE: Develop Radio Frequency Identification (RFID) communications protocols that can be integrated with off-the-shelf systems and will allow the collection of 50 or more moving RF transmitters in a portal application without requiring the transmitters to remain in the interrogation area for more than 1 second.

DESCRIPTION: Existing RFID systems operate as either batch or portal collection systems. In a batch collection system, RF transmitters packaged as RF tags are collected in a wide area. In a portal system, RF tags are collected as they pass an entry/exit way or "portal". Current portal RFID systems, whether active or passive, have several inherent limitations. Most systems require tags to remain stationary for a finite amount of time when multiple tags must be read at once. When several tags must past a portal at one time and they do not pause for interrogation, only a percentage of the tags will be acquired. The capability to read multiple tags as they pass a portal is needed in developing a system which can track items going in and out of containers, warehouse bins, etc.

PHASE I: Develop new RF communications protocols to handle the multiple access of 50 or more tags as they simultaneously pass through a portal at a high rate of speed. This protocol should be verified through a demonstration using appropriate hardware. Although it will be the developer's responsibility to identify the appropriate hardware to provide a true "portal" interrogation, the prototype system should be flexible enough to allow it to adapt to platforms being used by the Navy.

PHASE II: Integrate the protocol with RFID systems being developed by the Navy and demonstrate several prototypes of the system with this protocol in place. This demonstration will include all appropriate hardware and software to comprise a complete RFID solution.

PHASE III: Provide turnkey system for field testing at Navy installations and field exercises.

COMMERCIAL POTENTIAL: The commercial potential of this system spans several industries. It is applicable wherever an accounting of supplies is required. This includes applications in warehousing, transportation, supply, disaster relief, mail delivery, etc.

N97-144 TITLE: Inflatable Boat Propulsion System

OBJECTIVE: Propel a 15-foot rubber inflatable boat in the open ocean loaded with 2000 pounds at 18 knots in sea state three. Provide responsive propulsion in transitioning the surf zone and during slow speed maneuvers.

DESCRIPTION: The propulsion system must be safe for people in the water near the boat. The propulsion system shall be light weight with an objective of less than 140 pounds. It is desired that the system be capable of being submersed to a minimum depth of 75 feet of sea water for a minimum of 12 hours with preparation. After submersion the system shall be started without tools in 3-6 minutes and the system shall function properly. The system is desired to have a fuel economy of 3.5 NM per gallon of fuel. The system is desired to have a mean time to repair of 4 hours and a mean time between failures of 200 hours.

PHASE I: Develop a system design for a Inflatable boat propulsion system. The design must meet the requirements listed in the description. The propulsion concept shall be demonstrated.

PHASE II: Develop, fabricate, and test prototype. The prototype will be tested against the existing MARS engine and other competing systems to determine the optimum system to meet fleet requirements.

PHASE III: Transition prototype designs into Marine Corps inventory.

COMMERCIAL POTENTIAL: Provides safe, strong, and trustworthy propulsion system for small marine craft.

REFERENCES: Operational Requirements Document for Inflatable boat Propulsion System

N97-145 TITLE: <u>SPACE-BASED ASSET TRACKING AND INVENTORY SYSTEM</u>

OBJECTIVE: Utilize existing technology to develop a space-based tracking and inventory system for tactical military operations. This effort will leverage technology from existing DARPA R&D programs, customizing the equipment for use by Marine Air-Ground Task Forces and naval support forces (NSF).

DESCRIPTION: The location and status of tactical ground forces and their supplies is a serious problem for the MAGTF and NSF commander. Digital equipment now exists which, if properly integrated with naval communications and satellite systems, could provide three critical services - unit location, message traffic and tracking of supplies. Initiatives by DARPA, the Army's Dismounted Infantry Battle Lab, Torrey Science and SRI Corporations have tested a prototype system. However, this effort has not addressed specific Marine Corps or Naval Support Force concerns. These concerns include: masking of relay spacecraft by terrain; viability of flat screen technology for field use; software display symbology; utilization of ground and spacecraft transmitters for OTH fleet operations; integration into the current amphibious C^4I systems; and linkage of supply data via RF Identification Tags.

PHASE I: In conjunction with initiatives by DoD and private agencies, investigate the adaptability of the present equipment for use by Marine Corps and naval support forces. Analyze data from Exercises Warrior Focus (Fort Polk - Nov95) and Hunter Warrior (MCAGCC - Feb97) to address the above concerns. Conduct studies of: system integration with Marine and naval communications; range versus power for satellite uplink; terrain masking; advantages of GPS or Doppler navigation methods; modulation techniques and digital polling; viability of flat screen technology for field use.

PHASE II: Develop, assemble and demonstrate a system usable by Marine ground forces for two-way digital data relay between naval ships and ground forces. Equipment should be capable of: tracking and displaying location of multiple units; relay of typed messages; acceptance and linkage of RF tag data; transmission of map backgrounds and unit locations (using map symbology). The system must reliably link shipboard command centers (operating over-the-horizon) to units ashore which may be masked by intervening terrain. The demonstration must involve two-way ship-to-shore communications but may utilize non-encrypted line-of-sight transmissions or relay towers.. Components need not be ruggedized for tactical usage.

PHASE III: Demonstrate a deployable system capable of reliable digital linkage (BER 10^{-6}) to low-earth orbiting relay spacecraft. Improve the design for: rugged usage; all-weather conditions; reduced system maintenance and weight; improved reliability and service life. Data transmission must be encrypted and provide two-way real-time color displays of mapping backgrounds, unit designators and message traffic. Field equipment must be battery operable and man-portable. The radio frequency identification tags must reliably report from field interrogators to a shipboard control center.

COMMERCIAL POTENTIAL: This sort of data relay system has obvious applications for industry or other government uses. Examples include: business teleconferencing of charts, maps or graphics products, automated tracking and inventory of vehicles, vessels and premium cargo for the shipping industry; tracking and message functions for law enforcement, fire, fishing, forestry, hazardous material agencies, etc.

REFERENCES: Memorandum DCS:ESC-32 of 3 September, 1996. Contact Mr. Synnes for copies at (805) 982-1020.

NAVAL SUPPLY SYSTEMS COMMAND

N97-146 TITLE: Environmentally-Safe, Disposable Food Service Utensils

OBJECTIVE: The purpose of this work is to develop and demonstrate food service utensils (forks, knives, spoons, plates, cups, trays, "clamshells") that can be safely disposed of in marine environments and land environments. Military operations aboard ship require the use of disposable food service utensils when dishwashers are inoperative or when fresh water is unavailable for washing. Often meals are taken away from the mess as in the case of food consumed at watch stations. Disposable utensils are preferred for take-away meals because of the problems of storing and returning permanent utensils that are food-contaminated. Plastic utensils are widely available but international treaty precludes disposal of plastics at sea. Plastic utensils degrade so slowly that they are environmentally objectionable. A need exists for food service utensils that quickly break down when exposed to natural environments and pose no toxic hazard to marine life.

PHASE I: In Phase I, the contractor will demonstrate that food service utensils can be fabricated from combinations of natural materials that will quickly break down and which are environmentally-safe.

PHASE II: In Phase II, refine materials formulations and processing techniques so that test quantities of food service utensils can be fabricated. The contractor will subject the utensils to degradation testing. The contractor will subject the utensils to laboratory and field testing to demonstrate that they can fulfill their intended purpose with a broad range of foods (e.g., hot liquids).

PHASE III: In Phase III, the contractor will work with the restaurant industry to transition the products to the commercial marketplace.

COMMERCIAL POTENTIAL: Fast food restaurants such as McDonalds are intensely sensitive to their environmental image. Whenever possible, the large restaurant chains widely promote their initiatives to move toward environmentally-safe, disposable utensils and packaging. Materials that perform successfully in military applications would be attractive for hamburger clamshells and other food serving and consumption utensils.

BUREAU of NAVAL PERSONNEL

N97-147 TITLE: A Tool to Optimize the Predictive Accuracy of Personnel Selection and Classification Instruments

OBJECTIVE: To develop a methodology and tool to obtain a military or civilian applicant population personnel selection instrument intercorrelation matrix that will allow an accurate assessment of the most valid selection instrument and adjust for the effects of any prescreen or multiple hurdle testing.

DESCRIPTION: The Navy uses the Armed Services Vocational Aptitude Battery (ASVAB) as both a selection and classification instrument. The Armed Forces Qualification Test (AFQT), comprised of math and verbal ASVAB tests, is used for service accession. Various combinations of from two to four ASVAB tests (there are 10 tests measuring various aptitudes, skills, and knowledge) are used to classify accessions into occupational specialties. The Navy has eleven classification composites. Assessing the relative predictive accuracy of the composites is nontrivial; an increase in the predictive accuracy of .05 correlation points (validity) for a particular classification composite over all others has been shown by economists to save millions of dollars annually in reduced school attrition. Because school performance measures are only known for students who have completed training, it is impossible to specify the applicant population validates for the various classification composites.

This information is needed, because it is from the applicant population that the Navy will make future school assignments and school performance predictions. Further, the validity of the particular operational composite that is used for school selection is disproportionately attenuated (restricted) relative to other candidate composites due to the curtailment effect on the range of test scores occurring from selection at the school's minimum qualifying score. That is, test score variance is directly related to validity magnitude. Although there is a statistically based procedure to estimate the applicant population classification composite validates of interest, the theory and procedure do not take into account pre-selection screens, such as the Enlisted Screening Test (EST) that is administered at the Recruiting Stations. The impact of these and other prescreens, or multiple hurdle/sequential screening in the case of civilian personnel testing, diminishes the capability of assessing the relative predictive accuracy of personnel selection instruments.

PHASE I: Design a methodology to determine an unbiased Navy applicant or civilian personnel selection instrument intercorrelation matrix.

PHASE II: Develop, test, and demonstrate the procedures used in Phase I.

PHASE III: Produce software suitable for civilian as well as military use.

COMMERCIAL POTENTIAL: Industrial use generalizes to all organizations and Federal agencies that systematically administer personnel selection and placement tests in a sequential, multiple hurdle situation.

REFERENCES:
1. Held, J. D., and Foley, P. P., (1994). Explanations for Accuracy of the General Multivariate Formulas in Correcting for Range Restriction. Applied Psychological Measurement, 18, pp. 355-367.
2. Lawley, D. (1943-44). A Note on Karl Pearson's Selection Formula. Proceedings of the Royal Society of Edinburgh, 62, (Section A), 29-30.3. Linn, R. L. (1968). Range Restriction Problems in the Use of Self-Selected Groups for Test Validation. Psychological Bulletin, 69, 69-73.

N97-148 TITLE: Diagnostic Cognitive Task Analysis of Team and Multi-team Training

OBJECTIVE: Enable the trainers of teams and multi-teams to develop tests, keyed to existing procedural training, that can diagnose knowledge and skill weaknesses to be overcome by completing one or more training modules.

DESCRIPTION: Cognitive task analysis is a procedure used to develop the knowledge base to be incorporated into new instructional design. But it also has been applied to existing training material to produce improved, knowledge-engineered training. This effort will use cognitive analysis techniques to identify knowledge and skill elements in existing modules of training designed to improve the performance of teams and multi-teams. It will develop procedures to adapt and apply the techniques in the form of a diagnostic test keyed to different parts of the training.

PHASE I: Partition an example of existing team training into modules and apply cognitive task analysis, identifying knowledge and skill elements for each module. Develop procedures to convert the techniques used in eliciting the knowledge and skill information during the cognitive task analysis into a diagnostic test instrument that can be administered to team members.

PHASE II: Apply the cognitive task analysis techniques and test development procedures to training material for two teams that have different jobs. Categorize the team tasks that are being tested, and validate the test development procedures for each task category by administering the diagnostic test before and after team training.

PHASE III: Identify test development procedures best suited for different categories of team tasks. Prepare a diagnostic test development guide for use with existing team training that is based on cognitive task analysis techniques.

COMMERCIAL POTENTIAL: A guide to developing diagnostic tests based on the cognitive task analysis of existing training can be used in any work environment, civilian or military, that provides practice or exercises for teams or multi-teams.

REFERENCES:
1. DuBois, D., and Shalin, V. L. (1995) Adapting cognitive methods to real-world objectives: An application to job knowledge testing. In P. D.Nichols, S. F. Chipman, and R. L. Brennan (Eds.), *Cognitively Diagnostic Assessment* (pp. 189-220). Hillsdale, NJ: Erlbaum
2. Gordon, S. E. (1993) Conceptual graph analysis: Knowledge acquisition for instructional design. *Human Factors, 35(3),* 459-481.
3. Means, B., and Gott, S. P. (1988) Cognitive task analysis as a basis for tutor development: Articulating abstract knowledge representations. In J. Psotka, L. D. Massey, and S. A. Mutter (Eds.), *Intelligent tutoring systems: Lessons learned* (pp. 35-57). Hillsdale, NJ: Erlbaum
4. Randel, J. M., Pugh, H. L., and Wyman, B. G. *Methods for conducting cognitive task analysis for a decision making task* (NPRDC-TN-96-10). San Diego: Navy Personnel Research and Development Center.

N97-149 TITLE: Diagnostic Tool for Reengineering Team Training Using Cognitive and Team Process Analyses

OBJECTIVE: Conduct cognitive task analysis and team process analysis of complex, team-oriented tasks (e.g., combat information centers, engineering, air traffic control, nuclear plant). Develop multi-media technology for team performance diagnosis and improved training.

DESCRIPTION: Cognitive task analysis has been used successfully to improve medical diagnosis and land navigation skills of individuals. Team process analysis has been successful in reengineering businesses and organizations. This proposal applies these technologies to teams working with complex equipment systems in a Navy setting.

PHASE I: Perform cognitive task analysis and team process analysis on tasks currently performed in the Combat Information Center (CIC) or an engineering department aboard ship. These functions represent complex human-machine systems requiring technical knowledge, critical decision making, and coordination of team efforts. The analyses will focus on describing knowledge representation (strategic knowledge and meta-cognition), decision heuristics, and task coordination.

PHASE II: Develop and test a prototype multi-media technology for diagnosing team performance in a CIC or engineering environment. The multi-media deliverable will incorporate the results of the cognitive and team process analyses in Phase I. Based on the cognitive and team process analyses, the multi-media product will diagnose strengths and deficiencies in knowledge, decision quality, and team work. These results can be used as a diagnostic tool to improve existing training and develop new training methods.

PHASE III: Prepare easy-to-use multi-media package for use by Navy personnel in diagnosing team members performing complex CIC or engineering tasks during fleet training. Diagnostic results will be recorded and used as feedback for improved school house and operational training.

COMMERCIAL POTENTIAL: The technology can be adapted for civilian use with any team-oriented human-machine system (e.g., air traffic control, nuclear plants).

REFERENCES:
1. DuBois, D., & Shalin, V. L. (1955). Adapting cognitive methods to real-world objectives: An application to job knowledge testing. In P. D. Nichols, S. F. Chipman, and R. L. Brennan (Eds.), Cognitive Diagnostic Assessment (pp. 189-220). Hillsdale, NJ: Erlbaum.
2. Hammer, M. (1993). Reengineering work: Don't automate, obliterate. Harvard Business Review. March-April, 6-11.
3. Randel, J. M., Pugh, H. L., & Wyman, B. G. Methods for conducting cognitive task analysis for a decision making task (NPRDC-TN-96-10). San Diego: Navy Personnel Research and Development Center.

SPACE and NAVAL WARFARE SYSTEMS COMMAND

N97-150 TITLE: Target Imagery Classification System

OBJECTIVE: A methodology is needed for automated target classification based on Inverse Synthetic Aperture Radar (ISAR) images. The methodology used for classification must use target attributes that are transferable in alphanumeric form by message (e.g. spatial features). The methodology developed should support simple operator interpretation of imagery data and a reliable means for parametric based decision making by computer.

DESCRIPTION: The requirement exists for automated approaches for classification of surface and submarine targets. Navy Over-The-Horizon (OTH) Gold message sets provide a means to generate and distribute target parametric descriptions. Acoustic and electro-magnetic data sets exist (i.e. SIGNA and RADB sets) and can be used for classification by matching with a priori target databases (e.g. frequency lines). A new message set (i.e. ISAR) needs to be developed to similarly support classification based on spatial information. A responsive proposal will demonstrate prior work in subject area and an approach for obtaining government or industry sensor data sets.

PHASE I: Outline a consistent methodology for the finger printing of surface ship and submarine targets based on ISAR imagery. Identify measures of performance (MOPŌs) and metrology for assessment of classification algorithms used. Prepare final report that provides the justification and analysis that supports the methodology presented and documents the MOP's.

PHASE II: Develop a target database based on imagery derived attributes from data sources provided by government or industry. Define a prototype imagery message set with sensor attribute fields, develop test message files, and test classification algorithms. Refine algorithms and/or prototype message set formats as needed. Initial target database will be one commercial available such as Janes. Prepare final report.

PHASE III: Develop a prototype automatic target recognition (ATR) system. Investigate use of automated classification algorithms to interpret other sensor imagery sources (e.g. ASAR, FLIR, etc.) and explore potential message sets as appropriate. Show transition path for technology to future information systems such as Joint Maritime Command Information System (JMCIS) and other maritime systems.

COMMERCIAL POTENTIAL: Advanced technology to fuse imagery information for object identification is applicable to security systems. The automated interpretation of imagery information supports intelligent transport systems such as air traffic control and highway traffic routing and safety systems for automobiles, aircraft, and ships. The automated interpretation of imagery sensor information may be applied to the data from the NOAA satellites for other government and commercial business opportunities.

REFERENCES: These are unclassified references that provide a general overview of topic.

1. Operational Specification For OTH Targeting Gold (Rev B)
2. McCune, Brian P., and Robert J. Drazovich, ÒRadar With Sight and KnowledgeÓ, Defense Electronics, Vol. 15, August 1983, pp. 80-84, 87, 90, 93-96.

N97-151 TITLE: Interactive Audio Human System Interface

OBJECTIVE: Provide Naval warfighters, whether stationary or mobile, the ability to increase human productivity and responsiveness by providing the capability to access data from information systems through an Interactive Audio (IA) Human-System Interface (HSI) while simultaneously performing visually-oriented activities such as operating vehicles, ships, aircraft, equipment, and weapons.

DESCRIPTION: The importance of timely information in warfare is ever increasing. IA HSI capability facilitates the simultaneous access to information. It complements or provides an alternative to the visually-oriented HSIs (e.g., keyboards, video displays) characteristic of today's information systems. Using a basic set of commands, activated by voice or touch, users can interact with the systems to access information. The desired information will be available to the users in different audio formats depending on the information type. This effort should use existing technology to build an IA HSI capability that includes the translation, formatting, distribution, and user access to digital audio information. It will leverage computer, communications, speech synthesis, and speech recognition technologies.

PHASE I: Develop a design for an IA HSI capability and build a prototype that demonstrates the basic system capabilities focusing on the user environment. This system should have an efficient and responsive method for: (1) translating text into audio formats, (2) electronically distributing information to users, and (3) giving users easy interactive access to audio information. The solution should address a full range of audio needs from speech to high fidelity as well as fixed and mobile environments.

PHASE II: Develop and test full IA HSI capability and demonstrate in an operational environment. This demonstration should include translation algorithms, audio formats, data compression techniques, communications interfaces, data storage, portable user access devices, and digital-to-audio interface.

PHASE III: Prepare 'plug and play' IA HSI capabilities for integration into Naval information systems.

COMMERCIAL POTENTIAL: This IA HSI capability could be used in the commercial environment to: 1) provide a quality of life for the visually impaired; 2) give commuters a safe interactive audio-oriented media to access information such as an audio version of the newspaper while driving an automobile; 3) improve control center responsiveness (e.g., air traffic centers, railroad/subway scheduling centers, port control center, emergency response); and 4) increase the efficiency of the business environment by giving people an option to interactively access documents in audio format while mobile.

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(1) Newman W.M. and Lannming M.G., "Interactive System Design," Addison-Wesley, 1995;
(2) Baber, C. and Noyes, J.M., "Interactive speech technology: Human factors issues in the application of speech input/output to computers," Taylor & Francis, 1993;
(3) Keller, E., "Fundamentals of speech synthesis and speech recognition: Basic concepts, state of the art, and future challenges," Wiley, 1994; (4) Sayood, K., "Introduction to data compression," Morgan Kaufmann Publishers,1996.

N97-152 TITLE: Wide Range Tunable Filter

OBJECTIVE: Develop, for shipboard applications, a bus controlled tunable filter with a tuning range of 2 MHz to 2GHz.

DESCRIPTION: Tunable bandpass filters are used in transmit and receive communications circuits to control shipboard EMI/EMC problems. They are used in transmit circuits to reduce out of band emissions that would otherwise block reception. They are used in receive circuits to prevent strong cosited transmit signals from overloading sensitive receive circuits. Currently there are different filters for each frequency band (e.g. HF, VHF, UHF). A single filter covering the 2 MHz to 2 GHz frequency band and usable as a postselector in transmit circuits or as a preselector in receive circuits would simplify the shipboard communications architecture.

PHASE I: Design a bus controlled tunable bandpass filter with a tuning range of 2 MHz to 2GHz.

PHASE II: Construct and test a prototype of the filter design.

PHASE III: Transition to Navy procurement of the filters.

This effort is critical for the RF power distribution areas of Slice radio since in an open architecture this device will be required to implement single RF power module into the system.

COMMERCIAL POTENTIAL: This filter would be usable in any communications system where transmitters are located in close proximity to receivers.

N97-153 TITLE: Security for Reprogrammable Electronic Devices

OBJECTIVE: Develop, validate and demonstrate a method or methods to provide security for reprogramable electronic devices, such as a transceiver capable of multi-band operation. The security system must also be multi-level secure (MLS) and be store and forward capable.

DESCRIPTION: Technology, both hardware and software, is making it possible to design and manufacture devices that can be reconfigured and be capable of performing multiple functions. Applying security to such devices presents a new problem while at the same time opening the window for technology to provide security solutions that are as advanced and innovative as are the devices they must secure. In addition to providing security to the device for every functional capability, there is a need to provide MLS and a need for a store and forward capability.

Security has traditionally been a black box solution. Although some elements of hardware may need to be employed, maximum use of software should be explored and the latest technologies in key management and smart cards evaluated. The solution to this problem will enable Navy planners and designers to make maximum use of multiple function reprogramable electronic devices.

PHASE I: Evaluate current equipment and programs for reprogramable electronic devices. Identify the security issues and challenges that this new electronic technology presents. Investigate the latest techniques in cryptology and key management that could be applied to the issues and challenges presented by reprogramable electronic devices. Propose an affordable concept for secure operation of these devices applicable for military and civilian use.

PHASE II: Demonstrate the proposed concept in hardware and software, preferably using NDI/COTS products in a Navy system.

PHASE III: Transition the security system for reprogramable devices into the commercial marketplace.

COMMERCIAL POTENTIAL: There are a number of commercial applications for security on reprogramable electronic devices such as the banking/financial industry and cable TV/consumer services industry.

REFERENCES: Copernicus...Forward, Naval C4I Implementation, SPAWAR, Arlington, VA 22245-5200.

N97-154 TITLE: Transmission of Critical Aircraft Flight/Emergency Data via JTIDS/MIDS (Lx Band)

OBJECTIVE: Provide real-time flight recorder data reports directly to aircraft control/monitoring sites or FAA/ATC flight centers. Real-time flight recorder and emergency data transmitted via LINK-16 can augment and expedite investigation agencies in reconstruction analysis.

DESCRIPTION: Communications and data processing have progressed to the point where it is now feasible to widely employ MIDS/JTIDS technology on commercial aircraft. By tapping the flight data information sent to the Flight Data Recorder (FDR) information can be transmitted it in real-time to air traffic monitoring sites. Data written to the flight data recorder could be digitally captured and transmitted using an exiting international and DoD message standard (TADIL J). The receiving site would then have aircraft position and FDR/cockpit information in real-time. In the event of a mishap or accident, rescue agencies would be able to quickly determine the precise location of the incident as well as make initial determinations as to the cause of the incident.

PHASE I: Conduct an analysis to determine the feasibility of identifying and gathering flight data recorder and possibly other appropriate flight information, for transmission in the standardized message format (TADIL J). Determine what, if any, changes would have to be made to current message standards or data rate in order to implement a standardized transmission of FDR information. Determine what subset of MIDS/JTIDS transmitter/receiver technology could be implemented in an affordable manner to make this commercially acceptable and still support the message structure and data rate needed.

PHASE II: Develop a flight qualified prototype to demonstrate the utility of broadcasting aircraft position and flight configuration in a crisis situation. Demonstrate that the data can be transferred via MIDS/JTIDS technology to a ground site.

PHASE III: Utilizing the concepts developed, modify commercial aircraft such that FDR type information is transmitted in real-time thus augmenting the current process of physically recover the FDR hardware.

COMMERCIAL POTENTIAL: This type of concept would allow the National Transportation Safety Board (NTSB) access to Flight Data Recorder information soon after an incident occurs. Allow for safety analysis to commence immediately upon an aircraft emergency occurring. Future extension into possible real time analysis by ground controllers for pilot alert on potential malfunctions.

N97-155 TITLE: High Energy Density Battery

OBJECTIVE: Develop a lithium/carbon monofluoride (CFx) battery by repackaging existing CFx technology into the geometry (cylindrical with center hole) needed for underwater applications. The inherent safety and high energy density of the CFx electrochemistry will increase system safety and stability and provide 50% more operating lifetime compared with existing lithium/thionyl chloride batteries, without increasing weight and volume envelopes.

DESCRIPTION: Future underwater systems will be greatly limited by the size and weight of battery allocation. If properly packaged, existing lithium/CFx battery technology can provide 50% greater energy density, and therefore 50% increased mission lifetime, as compared with existing lithium/thionyl chloride batteries. Additional energy density improvements will be achieved by utilizing improved CFx materials as they emerge from ONR sponsored efforts currently underway. Improvements in CFx technology from other government funded efforts will be provided as GFE/GFI as they become available. Another CFx advantage is increased safety due to having a solid cathode material as compared to the liquid cathode of the thionyl chloride battery. Therefore there is less potential for the accidental emission of toxic liquid or vapor. Since CFx cells currently exist only as standard configurations up to the 'DD' size, this topic is focused on the development of large size lithium/CFx batteries in the geometry needed for underwater applications. Successful proposals will include demonstrated experience in fabrication of CFx cathode materials, fabrication of lithium anode materials, knowledge of CFx battery electrolyte and additive combinations, capability to design and fabricate CFx batteries up to 1000 ampere hours capacity, facilities and equipment necessary to accomplish prototype battery fabrication, and expertise of personnel.

PHASE I: Conduct a feasibility packaging study and design for the development of solid cathode CFx lithium battery cells in the size and geometry needed for future applications. Study variables shall include the possible effects of using innovative electrolytes, additives and electrode designs. Safety and environmental concerns shall be identified. The selected electrochemical system shall be assessed in small hermetically sealed cells. The study will be augmented by using the results of ONR work currently underway to develop new CFx cathode materials with increased voltage and capacity aimed at CFx cells in AA size for underwater mine batteries. All work will be documented in a final report.

PHASE II: Prototype large cells will be constructed and tested. Cell performance will be assessed in terms of improvement over existing lithium/thionyl chloride batteries.

A prototype battery will be designed based on the results of the prototype cell work. Reports will be issued at the Phase II midpoint and at Phase II completion.

PHASE III: A prototype battery sized for a selected mission such as ADS will be constructed and tested.

COMMERCIAL POTENTIAL: Lithium batteries in general have strong and growing commercial potential. Among primary lithium batteries, Li/CFx stands out with higher energy density, long shelf life and increased safety, and new low cost CFx materials will bring these advantages to a higher practical level. Smaller CFx cells will be useful in watches, portable calculators and medical implant applications (autoclavable). Larger cylindrical and rectangular CFx cells will be used in memory applications, radio sets, telemetry, photographic, satellite, oil well drilling, remote communications and general purpose applications.

REFERENCES:
1. Handbook of batteries, second edition, D. Linden, ed., McGraw-Hill, NewYork 1995.
2. NSWC/CD Contract N00167-95-C-4014, Investigation and Development of Lithium/Carbon Monofluoride AA-size Cells, Rayovac Corporation, Madison, WI.

N97-156 TITLE: Application of Standard Network Technologies to Surveillance Arrays

OBJECTIVE: Developed techniques and system to eliminate or characterize standard network packet latencies. Incorporating networking technologies into multi-sensor distributed surveillance systems requires very accurate knowledge of the time associated with each data sample.

DESCRIPTION: Standard networking topologies provide well defined interfaces to work from, enabling greater interoperability between systems and provide a clear separation between the transport and application layers. While sufficient data throughputs are now commonly available, sampling coherency of multi-sensor distributed data continues to be a poorly addressed issue. Maintaining sampling rate clocks (1 to 10 micro-seconds) on widely separated data acquisition nodes using only network supplied protocols is an issue that has not been thoroughly addressed. It appears that connection oriented network topologies such as Asynchronous Transmission Mode (ATM) or ATM-Sonet provide the best mechanisms for maintaining coherent sampling throughput a distributed data acquisition system. There are, however, certain latencies within an ATM based system that may be variable. Techniques need to be developed to eliminate or characterize these latencies so that sensor networks with coherent processing between nodes requirements can be implemented.

PHASE I: Investigate the applicability of connection oriented network topologies such as ATM-Sonet for use in surveillance systems involving distributed acoustic and non-acoustic sensors. Develop a set of system requirements for a prototype system which includes a method of maintaining sample rate coherency, and demonstrate feasibility of the method. All work will be documented in a final report.

PHASE II: Fabricate and test a prototype multiple sensor node system based on the network topology selected. Design the prototype for a modular distributed application, and conduct testing to validate the full range of networking and coherency performance issues. Analyze test results and provide recommendations for full scale application to production surveillance systems. All work will be documented in a final report.

Phase III Develop build to print package for production of a surveillance system.

COMMERCIAL POTENTIAL: Many scientific and geo-exploration disciplines require coherent sampling in distributed data acquisition systems. Developing coherent network based topologies would open up entirely new possibilities for data processing in the seismic and oil exploration industries

REFERENCES:

1. The ATM Forum, http://www.atmforum.com

2. Mark Rockwell, "Project ATM Network Provides Proving Ground", Communications Week, Nov. 27, 1995, p.5, http://techweb.cmp.com/techweb/programs/

3. MONET Testbed, http://fury.nosc.mil

4. John Rendleman, "Sun and Surf Over ATM", Communications Week, Dec. 18, 1995, p.21

5. Wesley Kaplow, "The Role of ATM in Unifying C^4I Networks", U.S.N. Next Generation Computer Resources Conference, Sept. 20, 1995, Washington D.C. http://ngcr.nwscc.sea06.navy.mil/agenda.htm

6. Pat Haleftiras, "ATM Navy Tactical Applications", U.S.N. Next Generation Computer Resources Conference, Sept. 21, 1995, Washington D.C. http://ngcr.nwscc.sea06.navy.mil/agenda.htm

7. John Walrod, "ATM Telemetry Systems for Sensor Arrays", U.S.N. Next Generation Computer Resources Conference, Sept. 21, 1995, Washington D.C. http://ngcr.nwscc.sea06.navy.mil/present/walrod.ppt

N97-157 TITLE: Code Analysis Tools for High Integrity Systems

OBJECTIVE: Develop code analysis tools to support the analysis of safety-critical, mission-critical systems.

DESCRIPTION: Ada 95 is an excellent language for the development of high integrity systems with safety-critical and mission-critical requirements. Specific guidance in the use of Ada 95 for the development of safety critical, mission-critical, and secure software is evolving through organizations such as the Safety and Security Rapporteur Group (ISO/IEC JTC 1/SC22 WG9/HRG). Their current work is leveraging a Canadian study addressing Ada95 Trustworthiness. Technologies are emerging to support the code analysis of such systems. Interfaces such as the Ada Semantic Interface Specification (ASIS) provide access to useful semantic and syntactic information available in the Ada 95 compilation environment. This SBIR concerns the development of a tool to assess source code for the analysis of its safety-critical and mission-critical properties.

PHASE I: Develop the design for a code analysis tool using ASIS to automatically analyze high integrity code based on guidelines derived from the HRG. [Those guidelines not practical for automatic analysis should be identified]. A design suitable for tool implementation will be produced. A draft user's guide for the tool use will be produced.

PHASE II: Develop the tool. This tool will be portable across all major Ada environments having an ASIS implementation. Successful completion of this phase will require demonstration of this tool on a large sample of SPAWAR provided Ada 95 code (approximately 500K). A final user's guide for the tool will be developed. Portions of the tool not commercialized will be placed in the public domain.

PHASE III: Support code analysis of SPAWAR programs.

COMMERCIAL POTENTIAL: Code analysis for Safety-critical and mission-critical properties is needed in many governmental organizations to include the DoD, NASA, DOT, DOE, and NRC. There are also significant needs in industry for such domains as avionics, ground transportation, medical, and process control.

REFERENCES:
1. Ada95 Trustworthiness Study: Guidance in the Use of Ada95 in the Development of High Integrity Systems; 12 September 1996; Canadian Department of National Defence, Chief of Research and Development, TR-96-5499-04.
2. ASIS Home Page: http://www.acm.org/sigada/WG/asiswg
3. HRG Home Page: http://www.npl.co.uk/npl/cise/systems/hrg.html

N97-158 TITLE: Detection using a Generalized Hough Transform Track- Before- Detect Processing of Split Horizontal Line Array Cross-Correlations

OBJECTIVE: The objective of this proposal is to provide a system capability to automate the detection, localization, and tracking of targets in shallow water scenarios characterized by many relatively short-range targets producing highly dynamic bearing measurements using extraction of bearing versus time information from split aperture horizontal line array cross correlations (Correlograms).

DESCRIPTION: Surveillance or tactical shallow water acoustic sensor system scenarios can be characterized by many relatively short-range targets producing highly dynamic bearing measurements. Under these conditions, significant temporal integration gain in the 2-dimensional bearing-time space can be achieved only by hypothesizing target motion through a 2-dimensional bearing-time space. Automating the detection, localization, and tracking of tracks targets in correlograms can be achieved through Track-Before-Detect processing of correlograms. In Track-Before-Detect processing, many possible tracks are hypothesized. Each hypothesized (constant velocity) tracks is defined by a set of track motion parameters, which assumes for a contract a constant course and speed over a given period of time. This contact motion description for example will fit into the framework of a generalized Hough Transform. In the underwater acoustic sensor context, the 2-dimensional input image is a finite duration time segment of the bearing-time space. Offers should show previous applicable experience in ocean propagation modeling that includes signals interacting with the bottom, and in underwater signal processing. An initial or example set of algorithms will be supplied GFI in an NRAD Technical Report if desired.

PHASE I: Development and implement the required algorithms on sample acoustic sea test data provided GFI by the ADS/AODS Program. Demonstrations will be performed on contractor's workstation with results, evaluations of performance, and algorithmic descriptions documented in a final report. Beamforming algorithms provided GFI.

PHASE II: Integrate and demonstrate tracking algorithms and system on a Navy parallel processor (NRaD's or NRL's) Using GFI multi-node data sets provided by ADS/AODS and FDS Programs. Beamforming algorithms provided GFI. Demonstrate a tracking process which clusters detections from individual data segments, and then fuses or links the detections across multiple data segments. A requirement of this tracking process is to obtain accurate and consistent contact tracks across beams and array nodes. A Final report will document work, evaluations of performance, and descriptions of all algorithms.

PHASE III: Provide the technical data and support to the Track-Before-Detect processing as a technology insertion into the ADS Program.

COMMERCIAL POTENTIAL: The technology development in this project could be applied to any image processing/detection problem where the object of detection in the image can be analytically represented. Applications may be found in image analysis problems from in undersea surveillance, the medical, geophysics, satellite, space, and radar fields. The final product could be sold to military prime contractors in the field of undersea surveillance.

REFERENCE:
1. Ballard, D.H., "Generalizing the Hough Transform to dectect arbitrary shapes", Pattern Recognition 13(2), pp 111-122, 1981.
2. Sevens and Shy, Application of the Hough Transform to Acoustic Broadband Correlograms for Passive Detection and Location, NRL/MR/5580-92-7182, January 7, 1993.
3. Brannan, R, NRaD TR#xxxx Technical Report, in preparation.

N97-159 TITLE: Generic Multiple Access Module Prototype for the PRIDE (Programmable Intelligent Digital Electronics) System

OBJECTIVE: Develop a prototype multiple access module which can be integrated into a PRIDE system.

BACKGROUND: A PRIDE system consists of a multifunctional hardware engine, middleware and application software modules. It accommodates many different Navy missions and operational scenarios. As a communications engine, it can be viewed as a chameleon radio performing the radio function needed at the time.

DESCRIPTION: A prototype module is to be developed that is able to model, analyze and control multiple access resource allocation algorithms implemented in a real-time fashion. It should make use of existing analytical methods and tools for the modeling and analysis of the underlying multiple access and switched network systems. The prototype must be integrated into the PRIDE system structure, interacting continuously with other system modules, serving to adaptively control the sharing of the available communications resources among the involved multi-media message streams. The module will be used to dynamically regulate the access of message flows from the PRIDE unit to the network using current status information and assign each active traffic stream its appropriate channel and access slots. In doing so, the module must integrate status information obtained from other PRIDE modules and from external signaling ports. Real-time and non-real-time applications must be supported so that each is guaranteed acceptable throughput, delay and delay jitter performance levels, on a priority basis.

PHASE I: Review the structure and modules implemented by a PRIDE system, as well as the underlying applications, traffic processes and link/network systems and services. Characterize the underlying interfaces with other PRIDE modules and with signaling ports. Develop the architecture, key approaches, models and analysis methods to be implemented in Phase II. Demonstrate the feasibility of the design by considering a Navy automated digital network system as a test case.

PHASE II: Develop the underlying access control and networking algorithms. Develop the associated analysis, synthesis and control procedures. Develop the computer software for the tool prototype. An easy to use graphical user interface should be employed. Demonstrate the tool's functions in a laboratory environment.

PHASE III: Anticipated future use in Navy shipboard and on-shore networks.

COMMERCIAL POTENTIAL: Commercial applications to packet radio networks, satellite networks, integrated terrestrial and satellite radio and wireline networks; wireless local and metropolitan area networks.

REFERENCE: JMCOMS Master Plan, SPAWAR; Copernicus...Forward, Naval C4I Implementation, SPAWAR, Arlington, VA 22245-5200.

N97-160 TITLE: Broadband Signature Information Identification and Extraction

OBJECTIVE: Identify and develop classification techniques based on passive broadband and wide band signal parameters.

DESCRIPTION: Many projected passive systems will use either broadband power detection or cross sensor correlation for detection and tracking. There has been indication that there are clues available in the information provided by such systems, that can provide target identification and a automatic target monitoring capability. There exists a need to explore this possibility in greater detail. In a cross correlation system some information on the signal-plus-noise correlation function is available. Multipath structure affects broadband signal with differing spectra in different ways, and these differences may offer information. Techniques are required which exploit available broadband clues to provide classification information.

PHASE I: Develop algorithms useful in extraction of braodband and wide band signature component clues and evaluated their effectiveness using real GFI sea test data. A data examination of passive acoustic broadband and wide band (1 Hz. to Several Hz.) signatures of various contacts including submarine will also be conducted to identify useful broadband correlation and wide band clues. All work will be documented in a final report.

PHASE II: Selected algorithms will be extensively investigated using real sea data (GFI) for regions with known shipping, i.e., known ships' identities and known ships' tracks, to evaluate system effectiveness under realistic operating conditions and environments. All work will be documented in a final report.

PHASE III: Successful algorithms shall be integrated into selected, evolving passive sonar systems such as SURTASS, ADS, etc.

COMMERCIAL POTENTIAL: The technology for providing solutions to this topic can also be useful in commercial applications such as remote machinery condition monitoring, radio astronomy, and volcano eruption /seismic activity prediction.

REFERENCES: McDonough, R.N., and Whalen, A.D. Detection of Signals in Noise. Academic Press, 1995.

N97-161 TITLE: Shipboard Auto-Tracking with a Stabilized Platform

OBJECTIVE: Develop a low cost, compact, stabilized platform system to correct for ship and target motion by integrating existing gimbals, servos, and software to support a 250 lbs electro-optical sensor.

DESCRIPTION: Missiles flying close to the surface of the ocean can be detected and closed-loop tracked using a passive electro-optical (E/O) sensor. Tracking of maneuverable targets is severely hampered by target motion, particularly in a low contrast and high clutter environment. Additionally, compensation for platform motion in any sea state compounds the shipboard tracking challenge. The tracking issues are made even more difficult when high resolution sensors with very narrow optical fields-of-view are used. The stabilized platform system must allow for hand-over from the ship's radar and be capable of auto-tracking the target with an E/O sensor once an operator designates a target. The tracking system must be capable of performing in a centroid or an edge tracking mode. This should be accomplished in a low contrast or cluttered environment. This program should lead to the demonstration of this enhanced imaging system at sea.

PHASE I: Show technical feasibility of a gimbaled platform with an E/O sensor capable of rejecting ship's motion, vibration, and flexure while centeroid or edge tracking in a sea state three. The concept should use modern technology and existing components (where possible) to minimize cost.

PHASE II: Develop and demonstrate the stabilized shipboard tracking system as described above.

PHASE III: Develop a plan for production and demonstrate a cost effective manufacturing approach.

COMMERCIAL APPLICATIONS: Once developed, this system could be used by law enforcement officials, Coast Guard, NASA, and others with commercial remote sensing applications.

N97-162 TITLE: Physics-Based Signal Processing Techniques For Next Generation Naval Systems

OBJECTIVE: Develop novel signal processing and beamformer techniques for next generation naval systems which utilize available information about the physical environment for robust detection, localization, and classification.

DESCRIPTION: Currently deployed Navy sonar systems use signal processing and beamformer techniques which effectively treat the underwater acoustic environment as a homogeneous medium. Only limited use of advanced modeling techniques such as AR and ARMA have been employed, and even these models cannot accurately model the true physical nature of the ocean. At the rate of maturation of current systems, which has been accelerated by leaps in low cost processing power, their basic signal processing paradigms will limit future improvements in performance, ultimately resulting in a performance ceiling for such systems. Next generation systems, if they are to offer substantial performance improvements, must account for the true physics of underwater acoustics. Techniques which fully utilize propagation models and physical environmental information, have demonstrated promising results but require comprehensive information and suffer severely when information is even slightly inaccurate. Thus, robust signal processing techniques which can take advantage of available environmental information are sought for next generation naval systems.

PHASE I: Develop a robust signal processing system including beamforming which accounts for ocean physics and demonstrate potential improvement over existing systems by developing and integrating a three-dimensional broadband shallow-water ambient noise model (from 10 Hz to 10,000 Hz.) which utilizes 3-D bathymetric and geophysical description of the propagation medium as inputs. ADS/AODS array node element data with bathymetric and geophysical data will be provided GFI. All work will be documented in a final report.

PHASE II: Implement a prototype on a Navy parallel computer (NRaD's or NRL's) and quantify and evaluate performance with archived GFI sea-test data. All work will be documented in a final report.

PHASE III: Provide technical expertise and support for technology insertion of a prototype system into a complete shipboard system for extensive at-sea testing.

COMMERCIAL POTENTIAL: Physics-based signal processing techniques can be applied to a number of industries that are challenged by complex physical phenomena. Examples of such include the cellular telephone industry, which must manage complex propagation of radio waves in cities, medical imaging and the propagation effects of acoustic and EM waves through tissues, and environmental science where dispersion of contaminants and/or organisms in land, air, and sea follow complex physical laws.

REFERENCES:
1. Krolik, J.L., ÒMatched Field Minimum Variance Beamforming in a Random Ocean ChannelÓ,J. Acoust. Soc. Amer., (92), 1408-1419, 1992.
2. Porter, M.B., et al., "Simulations of Matched Field Processing in a Deep Water Pacific Environment", J. Acoust. Soc. Amer.

(89) May 1991.
3. M. D. Collins and S. A. Chin-Bing, "A Three-Dimensional Parabolic Equation Model that Includes the Effects of Rough Boundaries," J. Acoust. Soc. Am. 87, 1104-1109 (1990). [This paper contains the first 3-D PE solutions that exhibit azimuthal coupling]
4. M. D. Collins, "The Adiabatic Mode Parabolic Equation," J. Acoust. Soc. Am. 94, 2269-2278 (1993). [This paper combines normal mode and PE techniques to obtain solutions efficiently]
5. G. J. Orris and M. D. Collins, "The Spectral Parabolic Equation and Three-Dimensional Back Scattering," J. Acoust. Soc. Am. 96, 1725-1731 (1994).[This paper solves a special class of 3-D problems that are useful for benchmarking]
6. M. D. Collins, B. E. McDonald, K. D. Heaney, and W. A. Kuperman, "Three-Dimensional Effects in Global Acoustics," J. Acoust. Soc. Am. 97, 1567-1575 (1995). [This paper shows that the approach of Ref. 2 can be applied to large-scale problems]
7. M. D. Collins, B. E. McDonald, W. A. Kuperman, and W. L. Siegmann, "Jovian Acoustics and Comet Shoemaker-Levy 9," J. Acoust. Soc. Am. 97, 2147-2158 (1995). [An application of the approach of Ref. 2 generalized to account for fluid flow]
8. M. D. Collins, B. E. McDonald, W. A. Kuperman, and W. L. Siegmann, "Horizontal Refraction of Gravity Waves by the Jovian Zonal Winds," Wave Motion (submitted). [Related to Ref. 5 but for internal gravity waves]
9. A. T. Abawi, W. A. Kuperman, and M. D. Collins, "The Coupled Mode Parabolic Equation," J. Acoust. Soc. Am. (in preparation). [Generalizes the approach of Ref.2 to include mode coupling]

N97-163 TITLE: High Performance Elastrometric Boot materials for Advanced Low Frequency Sonar Projector Applications

OBJECTIVE: The objective of this topic is to develop and evaluate state-of-the-art elastomeric boot materials for use with advanced high power low frequency sonar projector designs. New and innovative projector boot materials are required that have higher strength, and are more reliable, durable and last longer in a severe underwater environment.

DESCRIPTION: The next generation low frequency sonar projectors will require elastomeric boot materials with improved performance characteristics. New and innovative elastomeric resin systems and reinforcements are required which can withstand the mechanical and thermal loads imposed by these more compact, higher powered projector designs, while maintaining or improving the acoustic performance of the current boot materials. Cost effective elastomeric boot material formulations are desired that can be readily mass produced for high volume production. The ideal good material will provide a reliable, leak free barrier in a sea water environment for the service life of the projector. The boot material must withstand the stresses from active transmission, and varying hydrostatic pressure due to deployment and retrieval, over the life of the projector.

PHASE I: Define the material requirements for the next generation low frequency sonar projector boot designs. Prepare sample quantities of proposed boot material(s) for testing. Perform initial material testing and comparative evaluations on proposed boot material(s) and currently used boot materials. Optimize the proposed boot material formulation(s) for improved mechanical performance, acoustic performance, cost effectiveness and reliability. Define requirements for accelerated life environmental testing of proposed boot material(s). Prepare final report.

PHASE II: Perform extensive mechanical, acoustic and accelerated life environmental testing on candidate boot materials. Design and fabricate test article boots from candidate materials for installation on prototype next generation low frequency sonar projectors. Perform laboratory tests on the boot material for survivability in sea water, cycle test for life in high intensity acoustic fields (greater than ten million cycles), and for required acoustic and mechanical properties. Prepare final report.

PHASE III: Perform high volume production fabrication and cost analyses, and monitor production contract in support of low frequency projectors.

COMMERCIAL POTENTIAL: New and innovative projector boot materials and manufacturing technologies developed during this effort will have extensive commercial applications in the construction, oil and gas, and automotive industries.

REFERENCES:

1. Capps, R.N., Beumel,L.L., "Influence of Fillers on Constrained Layer Vibration-Damping Capabilities of Chlorobutyl Elastomers," J. Acoust. Soc. Am. 83, S82(a), 1988
2. Schulze, K.D.,"Investigation of Damping Characteristics of Constrained Layer Plates and Small Homogeneous Specimens," Thesis, September 1985, Naval Postgraduate School, Monterey CA, 9843-5100.
3. Duffe, J.V. et al (Polymer Phsics Group Naval Surface Warfare Center), "Dynamic Mechanical Properties of Poly(tetramethylene ether) Glycol Polyurethanes," and other papers in Am. Chem. Soc. Publ. Sound and Vibration Damping with Polymers, R.D. Corsaro and L.H.Sperling eds., 1990.

N97-164 TITLE: Reengineering of Distributed Source Code

OBJECTIVE: Reengineer the specification or design from the existing source code for a large distributed application.

DESCRIPTION: Methods and tools have emerged to reengineer specifications and designs from existing source code. There is a need to address reengineering for a large distributed application to facilitate program maintenance activities and evolve portions of the distributed system. This would make possible the redistribution of functionality within a legacy environment enabling the evolution of selected components with minor upgrades to other components.

PHASE I: Demonstrate the capability to evolve new code from existing code, such as the Space and Naval Warfare System Command's (SPAWAR) Integrated Undersea Surveillance System (IUSS). IUSS consists of approximately 3.6 Million Software Lines of Code (SLOC), including Ada 83, C, and assembler. Evolution capabilities to Ada 95 and C++ would be required. The demonstration will require close coordination and training with SPAWAR personnel and their contractors. A report would be required.

PHASE II: Provide extensions and modifications to use the program output in rehosting tools, such as the Rapid Application Specific Prototype Single Processor (RASSP) and RIPPEN™. Address issues associated with integrating new specifications from new requirements to the reengineered specifications from this tool. In particular, tool-generated specifications should agree with specifications used to automatically generate code from other tools. Mechanisms to reconcile differences should be provided. This capability should be demonstrated on at least one SPAWAR evolving program working closely with SPAWAR personnel and their contractors.

PHASE III: Support rehosting of programs such as the Advanced Deployment System (ADS) prototype to production.

COMMERCIAL POTENTIAL: There is much distributed legacy code that requires reengineering in the DOD, government, and commercial industry (e.g., banking).

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

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

DARPA has identified **41** technical topics, numbered **DARPA SB972-050** through **DARPA SB972-090**, to which small businesses may respond in the second fiscal year (FY) 97 solicitation (97.2). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical offices.

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

DARPA Phase I awards will be Firm Fixed Price contracts, **not to exceed $99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor. Phase II proposals are encouraged in the amount of $375,000 with additional funding available for optional tasks. The entire Phase II effort should not exceed $750,000.

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

DARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714

(703) 526-4170
Home Page http://www.darpa.mil

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

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the closing date of this solicitation. For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information. Successful offerors will be expected to begin work no later than 30 days after contract award. For planning purposes, the contract award process is normally completed within 30 to 60 days from issuance of the selection notification letter to Phase I offerors.

DARPA 1997 Phase I SBIR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Potential Post Applications ______

   i. Key Personnel, Resumes ______

   j. Facilities/Equipment ______

   k. Consultant ______

   l. Prior, Current, or Pending Support ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Company Commercialization Report - Appendix E ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. <u>**Do not**</u> use a cover. ______

   c. <u>**Do not**</u> use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

   c. Company Commercialization Report (Appendix E) is not included in the page count. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed Appendices A and B. ______

   b. Four photocopies of original proposal, including signed Appendices A ,B and E. ______

INDEX OF DARPA FY97.2 TOPICS

DARPA SB972-074	Vehicle Motion Pattern Analysis
DARPA SB972-075	Open Architecture Security Tools
DARPA SB972-076	Real-Time Network Performance Diagnosis
DARPA SB972-077	Accelerating Network Protocols
DARPA SB972-078	Multilevel Performance Frameworks and Tools for High Performance Systems
DARPA SB972-079	Mobile Oceanographic Sensor Suite
DARPA SB972-080	Multi-Modal Interface for Command and Control of Military Robots
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DARPA SB972-082	Robotic Mechanisms Capable of Attaching Themselves to Moving Ground Vehicles
DARPA SB972-083	Man Portable Smoke Generator
DARPA SB972-084	Two-Dimensional In-Plane Thermal Deformation Measurement for Large Area Substrates
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DARPA SB972-087	Continuous Apertures
DARPA SB972-088	Technologies for the Detection and Characterization of Deeply Buried Targets
DARPA SB972-089	Instrumentation for Nanostructure Analysis
DARPA SB972-090	Spatial-Spectral Automatic Target Recognition (ATR)

SUBJECT/WORD INDEX TO THE DARPA FY97.2 TOPICS

DARPA 97.2 TOPIC DESCRIPTIONS

DARPA SB972-050 TITLE: Applications for Carbon Nanotubes

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Accelerate the transition of carbon nanotubes from the laboratory into reliable, reproducible, economical, commercial-scale products for military and civilian applications.

DESCRIPTION: Carbon nanotubes, with diameters on the order of nanometers and lengths from nanometers to microns, are currently being studied in laboratories around the world. The unique properties of these materials (high strength, lightweight, high surface area, uniform size, high electrical conductivity, etc.) imply a wide range of potential applications. For example, lightweight mechanical structures could be built out of extremely high strength carbon nanotube fibers and composites. Alternatively, the high surface area per unit volume and high electrical conductivity of carbon nanotubes hold out the promise of fabricating high surface area, porous substrates for chemical catalysts and energy storage devices. While several research groups have developed novel techniques to synthesize large quantities of these materials, "real world" applications based on the unique properties of carbon nanotubes have heretofore been lacking.

PHASE I: Identify and develop a useful application for carbon nanotubes based on one or more of the unique properties of this material. Justify the basis for the proposed application via consideration of performance, manufacturability, and affordability issues. Demonstrate feasibility by fabricating a prototype component and measuring its performance. Select a relevant military application for demonstration in Phase II.

PHASE II: Demonstrate the unique capabilities of the application proposed in Phase I. Evaluate its performance relative to a component fabricated using conventional materials. Specifically address technical feasibility, manufacturability, reproducibility, and affordability for process/product scale-up.

PHASE III DUAL USE APPLICATIONS: Commercial promise is based on the many unique properties of carbon nanotubes and could lead to the fabrication of, for example, high strength fibers and composites; high surface area catalyst supports; anodes for high energy density batteries; hydrogen storage devices; and lightweight, high conductivity wires. Potential military applications include: high strength, lightweight fibers and composites for aircraft structures, satellites, personal body armor, etc.; anode materials for high energy density batteries and ultracapacitors; hydrogen storage media for advanced power sources; radar absorbing media; and electromagnetic shielding materials. Commercial applications are quite similar and include: lightweight composites; batteries, capacitors and energy storage media; high surface area catalyst support materials; and ultralightweight electrical distribution wires.

DARPA SB972-051 TITLE: Energy Harvesting

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop and exploit energy harvesting concepts that can be used to replace batteries in small DoD and commercial devices.

DESCRIPTION: The environment offers a wide variety of energy sources that can be exploited to provide power on a continuous basis. Unfortunately, the specific power and intermittent nature of these sources presents a major challenge for their use. Many DoD and commercial applications have power requirements that fall within the range of energy harvesting, i.e., $<$ 1 watt, for part of their duty cycle. Some of these systems require periodic power pulses on the order of 1-5 watts. While it may not be possible to generate power levels in this latter range using compact energy harvesting concepts alone, a systems approach that includes energy harvesting, storage, and conversion that is carefully matched to the required duty cycle could reduce or eliminate the need for conventional energy storage devices such as batteries. This approach would be highly valuable where battery replacement would impose too high of a logistics burden. While the obvious approach of solar photovoltaics combined with batteries is being exploited commercially and by the DoD, this solicitation seeks new approaches that reduce the size, increase the performance, or may not depend on solar energy as the energy source.

PHASE I: Develop integrated energy harvesting, energy storage, and power management concepts that would be capable of producing power in the 10's of milliwatts to 1 watt range for sustained periods and pulse capability to 5 watts. The system volume should be as small as possible (not to exceed 50 cubic centimeters). Select a relevant military application for demonstration in Phase II.

PHASE II: Demonstrate the energy harvesting/storage/power system as part of the military application selected in Phase I and evaluate its performance with respect to the traditional power source used for the application. Address the ability to manufacture these systems in high volume at low-cost.

PHASE III DUAL USE APPLICATIONS: Military applications of energy harvesting would include power for unattended ground sensors eliminating the need for battery replacement on the battlefield. This technology could be used commercially as a power source for embedded sensors in structures, e.g., bridges; airplanes; or to increase the endurance of consumer electronics, e.g., pagers; cellular phones.

DARPA SB972-052 TITLE: Materials for Frequency Adaptive Electronics

KEY TECHNOLOGY AREA: Materials, Processes and Structures; Electronics

OBJECTIVE: Develop thin and thick film materials and monolithic structures for frequency adaptable filters, antennas, oscillators, phase shifters, and other radio frequency (RF) devices utilizing the magnetic and electric field dependent properties of ferrites, ferroelectrics, and other novel oxides which can be tuned over an octave with overall loss tangents less than 0.001.

DESCRIPTION: The development of low loss ferrites, ferroelectrics, and other field adaptable oxide films will enable the development of a host of frequency agile filters, oscillators, antennas, and other RF devices that will have significant impact in reducing interference in secure communications e.g. SINCGARS, enhancing the frequency and beam steering agility of radar antennas while significantly reducing the size and complexity of conformal antennas for aircraft, missiles, miniature UAV's and satellites, etc. Efforts of interest will include both the development of processes for preparing very low loss tangent ferrites and ferroelectric films. Also of interest will be new oxide materials with enhanced dependence of the permitivity or permeability with electric or magnetic field respectively at low fields. Novel hybrid and monolithic structures and devices that can best utilize the frequency agility of these materials will also be considered.

PHASE I: In detail, define the process methodology for reducing the loss tangent in ferroelectric, ferrite, and other "tunable" materials or define novel device concepts that might circumvent the loss in existing materials. Preliminary tests of the proposed concept should be carried out.

PHASE II: Utilizing the process or device concept that was developed in Phase I, fabricate a functioning tunable component such as a filter, resonator or antenna element, and test it's properties, paying particular attention to the range of tunability and the effective quality factor.

PHASE III DUAL USE APPLICATIONS: Frequency agile filters, oscillators, and antennas could be included in the development of the next generation of broadband secure wireless communications that would have broad applicability throughout the three services. A Phase III program could develop the prototype of a frequency agile subsystem. Frequency agile RF technology will have a direct impact in commercial wireless telephony. The need for advanced signal conditioning in the next generation wireless communication systems will be severe because the number of networks and customers will be significantly enhanced over what it is today. The next generation military communication systems will also require this technology, thus, the opportunity for dual use.

DARPA SB972-053 TITLE: Novel Nanoelectronic Architectures

KEY TECHNOLOGY AREA: Command, Control and Communications (C3); Electronics; Materials, Processes and Structures; Modeling and Simulation

OBJECTIVE: Develop modeling and simulation tools for novel nanoscale devices which can be used as input to circuit simulators enabling novel device architecture for advanced microelectronics.

DESCRIPTION: Layered semiconductor materials and new fabrication techniques now permit nanometer scale electron devices with unique performance characteristics, i.e. Resonant Tunneling Devices and Single Electron Transistors and memories. Current directions in very large scale integration (VLSI) will be downscale limited frequency to less than 1 Gigahertz. Power dissipation will become a problem, both switching power and subthreshold or holding power. Complex interconnects will be an issue, i.e. interline capacitance and requirement for high conductivity in small wires and complexity in manufacturing. Cell area will not diminish accordingly because of need for large capacitance for static random access memory (SRAM) and dynamic random access memory (DRAM). Cache memory will be large and integrated locally to processor cells. It is expected that fabrication and testing costs will escalate.

Opportunities to address these problems rest with novel computer architectures based on ultrasmall devices. One approach is to use resonant tunneling devices (RTDs) in aggressively downscaled Digital Signal Processing. RTDs have promise for 100 Gigahertz operation [100 times complementary metal oxide semiconductor (CMOS)] and much lower power dissipation per gate (20 or more times smaller). Devices scale easily with the area of the vertical device. Memory elements of the same structure are possible.

PHASE I: Develop engineering models of devices and circuits with complexity to simulate and evaluate performance of a full circuit design, including adders, inverters, filters, analog-to-digital (A/D), etc. A/D concepts should be easily implemented in these devices as should memory devices formed in vertical geometries. Test designs based on limited 3-D integration are also desired.

PHASE II: The Phase II is essentially a continuation of the foundation laid in Phase I with more aggressive and detailed models and simulations, and full implementation into circuit simulators.

PHASE III DUAL USE APPLICATIONS: Continued microminiaturization makes inevitable the need to include quantum effects in chip design. The new class of devices based on quantum effects requires novel methods for their modeling. While the immediate market for such a package is within the research and development groups in industry, government, and universities, there is a potentially much larger market in the chip manufacturing industry. A powerful computational package will provide a major impetus to device design and subsequent subsystem development. Successful development of tools in Phase I & II will accelerate the development and military availability of high-speed, high-density, low-power electronics for processors in embedded and miniature systems, advanced digital radar, digital elint receivers, and secure, high data rate, digital networks.

DARPA SB972-054 TITLE: High Speed X-Y Stage with Sub 2.5 nm Accuracy

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop a dramatically improved mechanical stage technology as specified by sub 2.5 nm accuracy, speed of 1 m/s and turnaround time of <100 ms.

DESCRIPTION: Research leading to the development of a mechanical stage, capable of supporting and scanning the area of a 12-inch silicon wafer, that exhibits true two-dimensional accuracy and high speed. Efforts should address the repeatability of positional monitoring (through turbulence corrected laser interferometers or otherwise), the conversion of repeatability to two-dimensional positional accuracy through the use, for example, of recently researched calibration procedures; novel drive mechanisms; novel approaches to lightweight and stiff construction; thermal management; and other technologies needed to achieve significant advances in speed, accuracy and fast reversal. In some applications operation in vacuum is required, in others operation at atmospheric pressure is required.

PHASE I: Experimental test bed to demonstrate proof-of-concept that may, for example, meet the speed and accuracy values over a small (e.g., 5 cm x 5 cm) area necessary to establish credibility for a full size system meeting specifications.

PHASE II: Demonstrate a full size system combined with an electron beam column (or other sub 100 nm read/write head) to generate patterns at the scan rates and positional accuracies specified. Vertical excursions should be compatible with the read/write head selected for demonstration.

PHASE III DUAL USE APPLICATIONS: Creating a high-speed (>3 cm 2/s) sub 100-nm patterning and inspection/metrology capability, with pattern placement accuracy a small fraction of the minimum feature size, is a major problem confronting the development of future electronic systems. Within the next several years industry is converting to 12-inch wafers, and high speed stage motion will be required to maintain the throughput requirement of 60 wafers/hour for lithography and related steps in processing. The annual market for wafer exposure tools is about one thousand units per year. From a military standpoint, improved accuracy of 2-D stages will lead to improved optoelectronic and optical devices (e.g., VLSI photonic Devices, networks, and systems) requiring true two-dimensional accuracy. Commercial applications include improved overlay of microelectronic and optoelectronic circuits resulting from improved accuracy of mask-making, and water exposure equipment.

DARPA SB972-055 TITLE: High Resolution Spatial Light Modulators with Beam Steering Capability

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Promote the development of high resolution spatial light modulators that will enable the efficient interconnection and distribution of optical signals between high density source pixel arrays and receiver pixel arrays. The capability for optical beam steering, in addition to amplitude modulation, is an important consideration for spatial light modulators for these applications.

DESCRIPTION: Developments of efficient arrays of light sources, especially Vertical Cavity Surface Emitting Lasers (VCSELs), are enabling new applications of optical interconnections in high performance information processing systems. For many of these applications the insertion of a spatial light modulator between the source array and the detector array can significantly enhance the functionality of the complete interconnect system, particularly when the modulator can provide dynamically reconfigurable beam steering or multi-casting functions. Innovative approaches to spatial light modulator are sought that incorporate features that take particular advantage of the unique properties of VCSELs, such as their high spatial coherence and wavelength control. Candidate technologies include liquid crystal as well as other electro-optical materials such as semiconductor multi quantum well and photorefractive materials. Anticipated systems applications include memory access and digital optical signal processing.

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

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

PHASE III DUAL USE APPLICATIONS: The efficient, high resolution optical spatial light modulator, particularly with beam routing or multicasting capability, will enable a number of applications of smart pixel arrays and enhance the performance of optical signal processing systems. Military applications include optical two-dimensional array processors for target recognition, fast data base access, etc., and commercial applications include similar technology for image identification and page oriented signal processing.

DARPA SB972-056 TITLE: Arrays of High Sensitivity Optical Receivers

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Promote the development of optical receiver array technologies that will enable power efficient large arrays of smart pixels for use in digital optical signal processing systems.

DESCRIPTION: Research leading to innovative designs of light detector arrays and lower power receiver amplifiers will enable large arrays of receivers for optical interconnects exploiting recent advances in two-dimensional laser emitter arrays, particularly smart pixel arrays based on Vertical Cavity Surface Emitting Lasers. Improvements in laser design has resulted in sources with extremely low threshold currents to below 100 microamps. These reduced threshold power requirements for emitter arrays create the potential for low power, very high density arrays and for typical applications shifts the burden for further reduction of overall power requirements to the receiver array. Candidate technologies include detector designs that incorporate signal gain, such as avalanche photodetectors and semiconductor optical amplifiers, as well as schemes for implementing heterodyne detection or optical parametric amplification. Innovative approaches to implementing low power electronic amplifiers, such as wafer bonding of detectors for attachment to silicon electronics, are also of interest.

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

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

PHASE III DUAL USE APPLICATIONS: Power efficient receiver arrays will enable a wide range of optical interconnect applications in high performance information processing systems, particularly in the form of two-dimensional arrays that can function with complimentary two-dimensional arrays of emitters. Military applications include optically interconnected processors for such applications as fast fourier transforms (FFTs), space time adaptive processors (STAPs), etc., and commercial applications include similar technology for interboard or intercabinet interconnections in high performance computing systems

DARPA SB972-057 TITLE: Nanoscale Lithography

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

OBJECTIVE: Develop integrated sensing for nanoprobe based lithography to enable advanced microelectronic structures and devices.

DESCRIPTION: It is recognized that scanned-probe lithography is a likely candidate for a viable nanoscale lithography. In order to obtain sufficient speed, cantilevers with integrated actuation and sensing appear the most viable route. Process development needs to be optimized. Development of more sensitive piezo sensing films is required, as is the appropriate control electronics and protocols.

PHASE I: Demonstrate for scanned probes the development of integrated sensing, for example an integrated optical detector using solid state wave guide and interference, or other forms of integrated detectors that do not have the present problem of low signal, high crosstalk with actuator signal and hence low sensitivity.

PHASE II: Choose most likely avenue and build a prototype cantilever with integrated sensor that satisfies needs for nanoscale lithography in terms of sensitivity and speed.

PHASE III DUAL USE APPLICATIONS: Possible applications include scanned probe microscopes, diamond turning and other micromachining, MEMS sensors, real-time vibration control, etc. From a military standpoint, this effort would make the appropriate processing tools available to industry for advanced microelectronics and nanoelectronics and the associated ultra small and ultra dense device structures. This would benefit the development of electronic devices operating beyond the current trends of silicon scaling, thus, enabling the development of devices of extremely high-density, high-speed, and low-power.

DARPA SB972-058 TITLE: Advanced Microelectronics Structures and Devices

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

OBJECTIVE: Develop electronic devices with critical feature sizes well below 50 nanometers to accelerate the development and military availability of high-speed, high-density, low-power electronics for processors in embedded and miniature systems, advanced digital radar, digital elint receivers, and secure, high data rate, digital networks.

DESCRIPTION: Recent advances in materials processing and fabrication techniques have made it possible to produce device structures with characteristic dimensions down to a few atomic layers. New classes of devices are emerging or being conceived. Many of these manifest quantum mechanical effects such as tunneling, quantum phase interference, or coherence. Proposals are invited addressing processing, fabrication, characterization and modeling of quantum devices. It is important that fundamental issues be addressed while concentrating on devices with realistic potential for DoD applications. Room temperature operation is sought. Particularly relevant are devices with possible low power and high frequency or high speed applications. In modeling efforts, proposals are encouraged that incorporate self-consistency, dissipation, as well as realistic boundary conditions. Material efforts are encouraged to explore heterojunction systems for silicon based nanoelectronics and to explore chemical self assembly for its potential in nanoelectronics.

PHASE I: Clearly demonstrate the feasibility of the proposed approach and its relevance toward processing, fabricating, and implementing sub-50 nm devices and circuits for enabling microelectronics beyond current trends in IC semiconductor technology. Clear indication needs to be given as to how the particular approach and concept will improve performance characteristics in speed, power, and/or density.

PHASE II: Build upon Phase I work and, ultimately, demonstrate the properties, characteristics, and performance of device structures and circuits in the nanometer regime (well below 50 nm). Performance should clearly address the benefits to DoD in the regime of power, speed, density, and increased functionality of advanced electronics; and how it will lead to substantially improved performance in Phase III plans for system insertion and application in such areas as digital radar, elint receivers, signal processing and electronics for communications networks. Successful proto-typing in Phase II would increase the probability of a Phase III.

PHASE III DUAL USE APPLICATIONS: Work could lead to new concepts in advanced electronic devices, new device architectures, terrascale integration, and could be the basis for high-frequency signal generation, high speed switching, and multi-valued data storage. Capabilities of new electronic products include completely integrated functionality, embedded signal processing, high speed data processing, and high bandwidth. As greater performance is required for many of these components, reduced device and system power requirements have become key issues in advanced electronic technologies. This focus area will accelerate the military availability of selected emerging technologies, emphasizing high performance at substantially reduced power and operating at room temperature. For example, development and military availability of very high speed asynchronous transfer mode switching capabilities and high data rate signal processing for radar receivers will be advanced under this dual-use low power electronics effort.

REFERENCES:
1) "The National Technology Roadmap for Semiconductors," published by the Semiconductor Industry Association (1994).
2) "High-Speed Semiconductor Devices," ed. by S. M. Sze, Wiley-Interscience Publication, 1990.
3) "Semiconductor Quantum Devices," by Marc Cahay and Supriyo Bandyopadhyay, Advances in Electronics and Electron Physics, Vol. 89, Academic Press (1994).

DARPA SB972-059 TITLE: Development of Ultradense Silicon-Based Hybrid Single-Electron Transistors/Field Effect Transistors (SET/FET) Memories

OBJECTIVE: To exploit advanced nanofabrication and simulation techniques to achieve the practical implementation of single cells of hybrid memories based on single electron devices combined with conventional devices which are capable of operating at room temperature.

DESCRIPTION: Recent achievements of nanofabrication technologies demonstrated silicon-based SETs with electron addition energies E_c as high as 80 meV. At the same time, theoretical studies have indicated a possibility to use hybrids of such SETs and nanoscale FETs for implementation of ultradense non-volatile bit-addressable dynamic random access memories (DRAMs) with sub-nanosecond cycle. In order to make these memories functional at room temperature, E_c of the SETs should be increased up to 250 meV, corresponding to the SET island size of 4-5 nm. Patterning on such scale is unavailable for most university groups.

The goal of this work is to exploit the advanced nanofabrication techniques developed in microelectronics and nanoelectronics to achieve the practical implementation of single cells of the hybrid SET/FET memories capable to operate at room temperature.

PHASE I: Clearly demonstrate the feasibility of the proposed approach and the relevance of implementing the SET/FET technology in the room temperature, sub-100 nm device regime. The work would include detailed modeling and simulation of the memories and demonstration of adequate nanofabrication techniques and characterization.

PHASE II: Build upon Phase I work with the subsequent fabrication of the cells and their experimental testing and characterization. If successful, the work would serve as a seed for a large-scale industrial effort toward implementation of hybrid terabit memory technology as the future successor of the current mainstream silicon DRAM/electronically erasable programmable read-only memory (EEPROM) industry.

PHASE III DUAL APPLICATIONS: The work would lead to new concepts in advanced electronic memory applications enabling massive memory, higher packing density, and low power at high performance. The technology would serve to impact multimedia, portable libraries, spatial data technologies, system-on-a-chip applications, and pattern recognition problems. The work would lead to new ultradense background-charge independent silicon-based room-temperature single-electron devices and circuits for future terabit digital circuits and systems. The ultra high density memory technology which would be enabled would lead to DoD mass storage applications in avionics, signal processing, and image processing.

DARPA SB972-060 TITLE: High Speed Analog to Digital Converter Technology

KEY TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: Design and development of devices and circuits suitable for incorporation into high performance analog to digital converters. Applications are to defense radar, communications, intelligence, and electronic warfare systems.

DESCRIPTION: Research and development of devices and circuits are sought which will enable the operation of analog to digital converters (ADCs) with performance beyond the capabilities of current commercial ADC technology. For example, the best commercially available electronic, semiconductor ADCs offer approximately 6-8 effective bits (ENOB) and less than 60 dB spurious free dynamic range (SFDR) at 1 gigasample/sec (GS/s) sampling rate. High sampling rate (1-100 GS/s), high resolution (16-6 ENOB) ADCs offer the possibility of minimizing or even eliminating analog components such as down converters in receiver subsystems, with consequent savings in size, weight and power, and advantages in flexibility, maintainability, and lower cost. One of the major barriers to improving converter performance is timing jitter. Optical or electro-optical devices or circuits which help overcome this limitation are, for example, of interest. Uncooled technology is preferred. If a cooled technology is proposed, the power, weight, and reliability implications should be clearly delineated.

PHASE I: Provide feasibility of proposed devices or circuits through analysis and/or preliminary fabrication and testing.

PHASE II: Perform detailed design, fabrication, and testing of devices or circuits. If funding permits, incorporate components into a complete ADC. Estimate or, preferably, measure ADC performance including nonlinearities or harmonic distortion described by parameters such as ENOB, and SFDR. Ideally, the electronic components of a hybrid converter should be integrated with multichip module packaging technology. Provide an analysis of the manufacturability of the proposed devices and circuits.

PHASE III DUAL USE APPLICATIONS: High performance ADCs have commercial potential in applications such as imaging and communications, and in military applications in radar and electro-optical signal processing.

DARPA SB972-061 TITLE: Mixed Technology Integration

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: To develop innovative materials, processes, and manufacturing techniques for integration of multiple, mixed component technologies within a single module (or package). Mixed technology modules are envisioned to be completely self-contained systems within a single module, such as an entire instrument.

DESCRIPTION: A mixed technology module contains the integration of two or more die with digital integrated circuits, analog and rf circuits, power electronics, discretes, passives, memory, microelectromechanical systems (MEMS) and structures, photonics, surface acoustics wave devices, as well as others, within a single enclosure (package). Of particular interest is the application of extensions from advanced packaging to the package-level integration of leading-edge digital/analog microelectronics with a multiplicity of die from other technologies, such as, but not limited to, MEMS, and power devices. In a mixed technology module, new demands may be placed on the package and interconnect, in that the package and interconnect is the intimate interface among multiple disparate technologies as well as the interface among multiple disparate technologies as well as the interface to the environment beyond the module. Each of the various technologies may present its own challenges for die attach, encapsulation, interconnection, all coupled with manufacturing and operational compatibility issues. At the module level, thermal management, differences in the coefficients of thermal expansion are expected to be key issues, as are maintaining compliance, die attach, and replacement and rework. Approaches that provide radical innovations such as simplification to the manufacturing process and assembly of the mixed technology modules should be geared toward eventual flexible, low volume access to manufacturing in a high volume environment using leading-edge processes. Generalized and applied approaches to calibrate, verify, test, and screen integrated mixed technology modules are also of interest. While the digital multi-chip module application is addressing known good die, a similar approach may be necessary to verify operation of other types of components, such as MEMS or photonics, to mitigate module yield issues. A method of accomplishing burn-in and test may be a critical issue for modules with multiple technologies. Simulation tools exploring manufacturability issues specific to aspects of mixed technology integration may improve yields and ultimately lead to first-pass success. Also of interest are packaging and interconnect technologies for mixed technologies intended for extreme applications, such as high temperature (above 250 degrees C), high power/high power density, wide temperature cycling range, harsh environment, limited spatial volume, etc...

PHASE I: Perform detailed analysis of proposed approach to verify feasibility of applying advanced packaging technologies for integration of multiple, mixed component technologies. Develop implementation plan including integration strategy and fully quantify the anticipated benefits. As appropriate, perform proof-of-concept experiments to confirm validity of approach. Fully detail transition plans to commercialize and transition technologies to widest use in industry.

PHASE II: Implement a detailed technical plan that fully develops a specific technology integration to result in the availability of new materials, tools, processes, capabilities, etc. for mixed technology integration.

PHASE III DUAL USE APPLICATIONS: Mixed technology modules have application in a variety of commercial applications, from embedded intelligent sensors, to smart power integrated circuits, communications, and global reckoning systems. Mixed technology modules would provide solutions to integrating component technologies that meet performance and reliability metrics, as well as minimizing package volume. Mixed technology modules will have application for global positioning and reckoning systems, intelligent sensors and actuators embedded in process equipment, instrumentation and intelligent sensors and actuators that meet very small volume and power requirements. Intelligent power switches for high current loads such as all electric vehicles, highly precise reckoning and positioning systems, integrated systems with minimal volume, and highly intelligent sensors for a variety of battlefield applications.

DARPA SB972-062 TITLE: Materials, Simulation Models, and Tools for Fully Depleted Silicon-on-Insulator (SOI)

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Development of new material, simulation, and device technologies that enable or support 100X reduction in dissipated electrical power as compared to conventional approaches in semiconductor technologies that would be demonstrated in 0.18 micron line width and below technology generation.

DESCRIPTION: Approaches to reducing electrical power dissipation include reducing power supply voltages by use of SOI materials with special device and circuit configurations and architectural organizations. In this particular effort, the greatest interest is in those technologies that support or lead to power supply reductions to the range of 0.9-1.2V. With conventional semiconductor technologies such as silicon CMOS, simply reducing the power supply voltage may also reduce the device operation speed, affecting performance. Those approaches that offer to provide parity or improvements in performance, without compromise to functionality or circuit integration density, and are compatible or at least integratable with existing process flows are of greatest interest. Near fully- and fully -depleted, thin-film SOI materials and device technologies are under development for such applications and efforts that further advance the state-of-art in these SOI technologies are of very high interest. In addition, new simulation or unit manufacturing tools that lead to or provide such revolutionary power reduction capabilities are also of potential interest. While present generation or near-term technologies are not excluded from consideration, the greatest potential opportunities are in those approaches that are applicable at and below 0.18μm minimum feature size and offer the greatest promise for integration in semiconductor fabrication facilities. Revolutionary new SOI material production or material characterization and qualification techniques are of very high interest as are material post-processes that may dramatically improve the quality of the thin silicon or buried oxide. Other areas of potential interest include, but are not necessarily limited to, first principles simulation models that couple new material and process manufacturing parameters to device and circuit parameters, modeling tools for the SOI structure that lead to material and device improvements, and new approaches to process integration that are inherently flexible and easily incorporate low power unit processes.

PHASE I: A detailed technical approach that fully describes the specific technology, its integration strategy and the anticipated benefits is desired. Fully quantify the expected costs and impact on water flow and throughput. As appropriate, provide plans on transitioning equipment/process technology/simulation tools to widest use in industry.

PHASE II: Execution of the technical approach developed in Phase I. For materials, a fully characterized, stable, repeatable process for fabrication of cost-effective, ULSI-quality substrates. For tools, a prototype chamber with demonstration of the process capabilities and extendibility to scaleable, manufacturing. Provide a strategy for completing commercialization and qualification of equipment. For simulation models, complete numerical or analytic implementation, verification, calibration, and integration into appropriate platforms or tool suites, with a demonstration of capabilities.

PHASE III DUAL USE APPLICATIONS: The development and availability of thin film, SOI materials and processes for design and production will lead to an expansion of the commercial markets for integrated circuits in low power applications. The growth rate of the low power segment of the commercial market is accelerating. Tools and technology developed in this program should find large demand from both captive and merchant producers of semiconductor integrated circuits. SOI technology will be part-for-part compatible with silicon/CMOS and will be able to replace any digital component. The SOI part will be much lower in power and higher in performance. Processors, memories, application specific integrated circuits, and full custom design will benefit from implementation in SOI from reduced power without compromised performance. Low power integrated circuits will be used in man portable electronic systems being designed for deployment in battlespace environments, including advanced digital radios and communications systems, personal information assistants, and embedded intelligent sensors.

DARPA SB972-063 TITLE: Programmable Exposure Sources for Maskless Lithography

KEY TECHNOLOGY AREA: Electronics; Manufacturing Science and Technology (MS&T); Materials, Processes, and Structures

OBJECTIVE: Develop electronically programmable exposure sources for maskless lithography for fabrication of microstructures, including advanced microelectronic devices and micromechanical structures.

DESCRIPTION: Emerging technologies can be exploited to develop lithography tools which generate the desired pattern electronically in real-time during the substrate exposure, thus eliminating the cost and time required for conventional mask tooling. The resulting programmable source will be an engine substitute for the source and mask configurations in conventional lithography tool designs. Innovation is required to simultaneously meet the demanding needs for pixel count, pixel size, and throughput. The approach should be compatible with the myriad other requirements of lithography systems which enable cost-effective manufacturing. Candidate exposure radiation sources include both photonic (optical, EUV, x-ray) and charged particles. Microelectronic applications should extend to design rules of 0.1 microns and below, with wafer exposure rates of tens of wafers/hour. Typical applications for micro-mechanical structures would address large areas (> 10 cm sq.) with geometries and depths of focus > 1 micron.

PHASE I: Conduct a detailed study of candidate approaches and preliminary experiments to support choices for Phase II effort.

PHASE II: The Phase II will include the fabrication, integration, and characterization of subsystem components to demonstrate effectiveness of the concept at the prototype level. To provide for insertion into the end-use lithography tool, the contractor should interact with potential tool suppliers on issues of compatibility between the source and the tool.

PHASE III DUAL USE APPLICATIONS: The developments will provide potential solutions in the key areas of microelectronics and micromechanical structures. Either area has a ready commercial market providing a strong "pull" for new technology developments. The developments of this program will provide significant benefits in both time and cost of new product developments. Similarly, these developments will enable cost-effective "low volume" production through reduction of non-recurring mask tooling costs. From a military standpoint, programmability in exposure sources eliminates the need for costly mask tooling, thereby providing cost-effective production of microelectronics at the low production volumes typical of military systems. From a civilian standpoint, programmability in exposure sources will reduce development time for new integrated circuits resulting in both cost savings and time-to-market for new electronic products.

DARPA SB972-064 TITLE: Imaging Materials and Processes for Microstructure Fabrication

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop new materials and processing to provide patterning for fabrication of microstructures, including advanced microelectronic devices and micromechanical structures.

DESCRIPTION: Innovative approaches are required to exploit opportunities in fabrication of new microelectronics and micromechanical structures. New materials are emerging which offer advantages in feature size and placement, increased tolerance in depth of focus, conductive resists, improved edge definition, and improved selectivity in new etch environments. Examples include inorganic resists, self-assembly materials, resist materials targeted for future exposure sources, and conductive resists. Processing innovations may include new tool applications and processing combinations which result in structures with some of the advantages listed above. Microelectronic applications are for design rules of 0.1 microns and below; typical applications for micromechanical structures would address large areas (> 10 cm sq.) with geometries and depths of focus > 1 micron.

PHASE I: Conduct a detailed study of candidate approaches and preliminary experiments to support choices for Phase II effort.

PHASE II: This effort will include the development and optimization of materials and processing, and the fabrication of appropriate device structures to demonstrate capabilities and to enable evaluation of developments.

PHASE III DUAL USE APPLICATIONS: The developments will provide potential solutions in the key areas of microelectronics and micromechanical structures. Either area has a ready commercial market providing a strong "pull" for new technology developments. The micromechanical structures area is a rapidly emerging technology, with new applications appearing across a broad spectrum of applications including such diverse areas as controls, sensing, robotics, etc. Microelectronics has an established presence in all facets of society, but its continued evolution is threatened because of reduced processing tolerances in the lithography area. From a military standpoint, new imaging materials will provide improved resolution and image placement, providing higher performance (e.g. frequency, low noise amplification, etc.) for microwave and millimeter wave circuits for use in radar, communications, electronic warfare, etc. From a civilian standpoint, the improved resolution and image placement from new imaging materials will improve operating speeds of microprocessors and digital signal processors, as well as increase the bit capacity of memory chips.

DARPA SB972-065 TITLE: High Speed Optical Memory Access

KEY TECHNOLOGY AREA: Command, Control and Communications (C3); Computing and Software; Electronics

OBJECTIVE: This program is aimed at developing and demonstrating technology to significantly enhance the throughput speed of optical memory access by exploiting recent developments in 2-D parallel access optical elements and recent developments in volume optical storage material. The focus of the program will be to develop and demonstrate prototypes of high speed parallel access to volume optical memory, including 2-photon and holographic. This capability will have high payoff to both military and commercial applications. The areas of primary interest are: A) development of optical I/O circuits; B) optical beam formation and deflection approaches; and, C) enhancements to volume optical storage media which will enable rapid read/write capability.

DESCRIPTION:

PHASE I: Rapid parallel memory access to read-only-memory (ROM), electronic or optical memory, where one may achieve the access speed of random-access-memory (RAM), but with Gbyte capacity; the Phase I portion would perform research and development into assessing the limits of parallel 2-D optical I/O throughput for both read and write, as well as assessing the tradeoffs of page versus bit serial access to volume optical storage. Of particular interest are the relative costs/benefits of various component options: optical emitter-based or modulator-based architectures; choice of holographic optical elements or micro or macro optical distribution schemes; the choice of detector elements in silicon or III-V material; the choice of packaging scheme for the optical to electronic integration, such as liftoff, fusion/thermal bonding, or bump bonding. Preliminary experimental concept demonstration of the capability of parallel access to enhance throughput are expected.

PHASE II: The Phase II effort will be an extension of the techniques developed in Phase I to develop and demonstrate a viable 2-D optical addressing and access system. It is important to demonstrate the potential of the approach to eventual scale up to full scale production and the high throughput optical input/output capability. DARPA expects the contractor to perform detailed tradeoff studies conducted up from each of the components to their respective architectures and systems. This approach will enable a thorough and informed basis for formulation and selection of the preferred component, architecture, and system. It is expected that critical components will be fabricated and a prototype demonstration of the complete sytem will be demonstrated.

PHASE III DUAL USE APPLICATIONS: Demonstration of the full potential of this technology promises to provide significant payoff in a very broad spectrum of information processing systems applications having major commercial and military significance. Fast access to stored terrain maps and intelligence will allow aircraft such as F-15,16 fighters to fly under all-weather, day/night conditions with radar off. Surveillance, reconnaissance, and intelligence communities of DoD all need rapid access to stored information. This SBIR impacts a broad range of military needs. Commercial applications include large data bases, and information storage and retrieval systems for banking, insurance, computer communication, and commercial avionic information systems. Leveraging of commercial digital video discs (DVD), optical discs, and commercial emerging 3-D optical storage systems, by developing parallel access techniques, are commercial technologies that potentially could be inserted into defense systems as a result of this SBIR project.

DARPA SB972-066 TITLE: Energy Scavenging for Personal, Portable Computing

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop alternative energy sources or energy conversion techniques to complement and/or supplement conventional battery and solar energy sources for worn and carried personal information products.

DESCRIPTION: Batteries are the primary energy source for computer and information products used by individuals engaged in productive work in remote locations. Battery technology is not keeping pace with the demands for increased computational complexity in wearable and carryable products used in field environments. Alternatives to conventional battery and solar energy sources obtained by scavenging energy from human energy sources, such as kinetic energy generated by the movement of extremities (legs, arms, fingers, etc.) or thermal energy dissipated by muscle contractions, and the subsequent conversion of these energies to enable the charging of batteries are sought. Also sought are innovative alternate methods to capture and convert energy from ancillary carried products. Examples of these might be conversion of kinetic and/or thermal energy obtained from firing a weapon or from miniature generators. Novel methods to obtain efficient energy conversion are also sought.

PHASE I: In detail, provide alternative energy source approaches, energy conversion mechanisms and efficiencies, methods to simultaneously utilize multiple energy sources, and battery charging approaches. Provide concepts, analyses and preliminary designs that show how the approach would provide enhanced energy utilization for a portable system.

PHASE II: Design and develop an energy scavenging system and demonstrate in a side-by-side comparison with a conventional, battery operated, portable electronic product.

PHASE III DUAL USE APPLICATIONS: Portable computing and information products such as laptop computers, personal digital assistants, and cellular phones can benefit from the use of complementary and/or supplementary energy sources to extend the time between battery changing or recharging. Alternative energy sources have strong applicability to individuals (military, industrial, commercial) that are engaged in productive work and are remotely located from conventional information resources. There is direct application to military programs like the Army's Land Warrior and 21st Century Land Warrior programs, as well as DARPA's Small Unit Operations program. In the industrial area, applications include supplying energy to information products used by individuals working in the field, i.e., electric utility, telephone linemen, firefighters, law enforcement, etc.

DARPA SB972-067 TITLE: Tools, Algorithms, and Sampling Techniques for Logistics Execution Monitoring Technology

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

OBJECTIVE: Develop logistics execution support algorithms and data sampling techniques that can provide real-time information to support the development of alerts and triggers for rapid logistics replanning processes.

DESCRIPTION: Research and development of technologies that support real-time visibility of assets in the logistics pipeline, and the infrastructure that support their conveyance, are needed to support the DARPA Advanced Logistics Program (ALP). Areas of interest include the development of "sentinels" that understand the explicit assumptions and expectations of plans, sample and interpret execution data, detect deviations, and trigger logistics replanning processes. Other important aspects include innovative and comprehensive methods for monitoring the execution space, including the condition of the infrastructure, as well as, assets in motion and in storage, and inexpensive labor free methods for aggregation and deaggregation of materials in flow. These solutions require advancement of multiple enabling technologies that support execution monitoring in a continuous replanning environment and their integration into an end-to-end system solution.

PHASE I: Define and evaluate algorithms that provide for the creation of plan sentinels" that capture expectations and assumptions of logistics plans and provides triggering logic to initiate replanning when deviation thresholds are detected. Investigate techniques and hierarchical system concepts involving active and passive tags that can be used to support visibility of real-time logistics flow, aggregation/deaggregation processes, and infrastructural state. Phase I efforts are focused at enabling technologies within DARPA ALP. Knowledge of the DARPA ALP system architecture will be required to facilitate integration during Phase II.

PHASE II: Integrate algorithms and sampling techniques into the system architecture being defined and developed as part of the DARPA ALP. Demonstrate the creation of sentinels" in support of a changing logistics support plan and replan triggers caused by disruptions of flow and/or loss of infrastructure. Demonstrate the potential for automated aggregation/deaggregation processing at critical nodes in the logistics pipeline.

PHASE III DUAL USE APPLICATIONS: From a military standpoint, this technology will provide improved capability to monitor force deployments; the distribution of material, supplies, and equipment; and the condition of infrastructure supporting logistics operations. Examples include tracking the movement of military transport aircraft, cargo ships, trucks, and trains, as well as the military equipment and supplies being transported. It will also provide the capability to monitor the condition of sea/aerial ports of embarkation/debarkation, road networks, and highway/rail facilities. This improved visibility will result in faster planning and replanning during contingency operations, and improve the day-to-day efficiency and effectiveness of the logistics pipeline. From a commercial standpoint, these advanced monitoring technologies have a direct application to commercial logistics-oriented operations. The greatest potential value is in areas related to "just-in-time" manufacturing, supply-chain management, inventory management, physical distribution, and the management of transportation carrier operations, i.e., rail, truck, ship, and aircraft operations. It also has the potential to improve carriers' abilities to provide real-time feedback to the customers on the status of their individual shipments.

DARPA SB972-068 TITLE: Multi-Platform Real-Time 3-D Visualization System Urban Environments and 3-D Terrain Imagery

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Create a cross-platform (PC, Mac, Sun, SGI, etc.) real-time 3-D visualization system capable of visualizing ultra-high resolution urban environments immersed in global unlimited 3-D terrain imagery simultaneously.

DESCRIPTION: Most high performance visualization systems are currently limited to high-end graphics deskside work stations costing in excess of $100K. The low-cost of high performance dedicated graphics hardware for personal computers and low-end work stations has made it possible to create a cross-platform system that can visualize virtually infinite amounts of high-resolution data in real-time. Along with the enabling hardware, a highly integrated software system that can effectively utilize the hardware with advanced graphics and data handling technologies needs to be developed. Today, this capability only exists on costly, difficult to use, and inflexible high-end systems. An advanced system is required to: 1) Visualize unlimited amounts of terrain and structure data in urban environments (e.g., large cities and military compounds containing complex structures) in real-time; 2) Implement state-of-the-art rendering and data processing techniques to provide the best possible performance for all types of data; and, 3) Run on a wide variety of systems ranging from high-end graphics work stations to standard PCs with dedicated graphics hardware.

PHASE I: Define the visualization system to be developed, requirements, software architecture, high-level design, technical approaches, tradeoffs, and enhancements over current approaches and existing tools. Demonstrate proof-of-concepts on at least two different graphics platforms.

PHASE II: Produce a prototype implementation of the system. Demonstrate capability on at least three different graphics platforms (high and low-end systems).

PHASE III DUAL USE APPLICATIONS: The emergence of low-cost 3-D hardware for the PC platform has made practical the application of 3-D terrain and building visualization technology to address a variety of problems such as building physical security analysis (counterterrorism), urban planning, forestry management, geographic information systems, and architectural visualization. This program could greatly enhance the capability of businesses (located abroad or in the United States) and government agencies to conduct analysis of threats from terrorism or crime and to assist them in taking prudent measures to reduce their risks of terrorist or criminal attack. Portable visualization of urban settings enables any user to view their organization/businesses in a manner useful to identifying risks from bombs, sniping, or other security threats, and taking appropriate protective measures

DARPA SB972-069 TITLE: Continuous All-Source Region Monitoring

KEY TECHNOLOGY AREA: Battlefield Awareness

OBJECTIVE: Combine all-source sensor data and operator-supplied activity knowledge into a continuous picture of events occurring among one or more sites of interest. Track vehicles, associate them with expected patterns of activity, and detect outliers and changes from normal patterns which may indicate illicit or aggressive behavior.

DESCRIPTION: Modern sensors provide a very flexible means to observe the battlespace. In particular, they allow around-the-clock scrutiny of high-interest sites (command posts, border crossings, facilities that may produce weapons of mass destruction) without the use of ground personnel. The purpose of this effort is to build an interactive inferencing system to support remote site monitoring.

The sensors of interest include radar (including MTI, HRR, and SAR modes), electro-optical (both IR and hyperspectral imaging sensors), SIGINT, and acoustics deployed both on airborne platforms and on unattended ground stations. The objects of interest consist of vehicles, people, and cargo. The activities of interest include transportation of goods, people, and vehicles; conversion of supply materials into products; and meetings among key people.

Well-established physical models exist to relate sensor reports to vehicle locations and movements. Fewer models exist for the activities which vehicles support, especially in third world cultures. Proposers to this topic should display knowledge of existing sensor, vehicle, and activity models, and propose ways for analysts to assist the inference process by posing their own hypotheses, models, or scoring criteria.

Conventional correlation and fusion systems adopt a policy of f using like-source data first (e.g., form MTI tracks, SAR groups, and SIGINT correlations separately), and then combining these intermediate products into an all-source picture. This topic solicits approaches that do not impose any artificial constraints on the processing chain. Rather, it seeks integrated algorithms that combine all sensor data together in order to maintain the most accurate, high-resolution estimate of vehicle movements, events, and activities.

PHASE I: Define an integrated tracking/activity analysis architecture. Specify algorithms to achieve each function. Identify potential users. Identify analyst and user interfaces. Recommend modalities and displays for each interface. Postulate operational scenarios faced by the potential users. Analyze the performance of the integrated system on those scenarios. Compare it to the performance of existing architectures. If substantial improvement exists, develop a top-level software design.

PHASE II: Complete software design, implement, and demonstrate continuous all-source monitoring to user community. Incorporate user feedback into an enhanced demonstration.

PHASE III DUAL USE APPLICATIONS: Pilferage affects many sites, from individual pharmacies to tropical hardwood logging concessions. Present-day site security systems rely on simple triggers and alarms which cannot detect pilferage during normal activities. While respecting various legal prerogatives, site surveillance systems that perform integrated tracking of individuals or vehicles can reduce theft and piracy. Monitoring of denied areas such as separation zones in a peace keeping operation or threat zones to enforce base security are two of many military applications.

DARPA SB972-070 TITLE: Innovative Approaches for Embedded Real-Time Ultra High Frequency/Very High Frequency (UHF/VHF) Synthetic Aperture Radar (SAR) Image Formation

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop innovative, efficient image formation algorithms for Foliage Penetrating SAR.

DESCRIPTION: High-resolution VHF/UHF SAR image formation is very challenging due to radio frequency interference (RFI) and due to the large integration angle and large fractional bandwidth. The large integration angle leads to severe range migration of the target during image formation. One computationally efficient algorithm is the Range Migration Algorithm [1], but this algorithm is very sensitive to off-track motion [2] and tends to require large computer memory and very large Fast Fourier Transforms (FFTs). Innovative hardware and software approaches for real-time onboard VHF/UHF processing are sought. Solutions must show potential improvement in cost, weight, power consumption, volume, processing speed, and/or image quality and must include or be able to accommodate known RFI mitigation techniques.

PHASE I: Perform algorithm and hardware designs, and parametric tradeoffs.

PHASE II: Develop, validate, and benchmark an image processor suitable for real-time operation on the appropriate platform.

PHASE III DUAL USE APPLICATIONS: Synthetic aperture radar imaging is finding ever-broadening application in military battlefield awareness and commercial mapping, land-use planning, civil engineering, and disaster assessment. The trend is to require foliage penetration and high resolution. Techniques to improve efficiency and quality of this technology would have great commercial potential.

REFERENCES:
1) Walter Carrara, Ron Goodman and Ron Majewski, "Spotlight Synthetic Aperture Radar, Signal Processing Algorithms", Artech House, Norwood MA, 1995.
2) Walter Carrarra, Sreenidhi Tummala, and Ron Goodman, "Motion Compensation Algorithms for Widebeam stripmap SAR,", in Algorithms for Synthetic Aperture Radar Imagery II, SPIE Vol. 2487, (D.A. Giglio Ed), (Orlando FL), SPIE, April 1995.

DARPA SB972-071 TITLE: Instrumented Sensor Suite for Controlled Imagery Acquisition

KEY TECHNOLOGY AREA: Computing and Software; Sensors

OBJECTIVE: Design, build, and demonstrate a prototype system to allow the acquisition of outdoor imagery under geometrically controlled conditions.

DESCRIPTION: The acquisition of metrically accurate imagery under field conditions is vital for an increasing variety of purposes such as collecting source imagery for the construction of three-dimensional models for visualization of militarily significant structures, for monitoring field tests of military hardware, and for acquiring data to be used for training and testing of automatic image processing algorithms under controlled circumstances. Photogrammetric techniques can be employed to measure scene characteristics, but work best when imagery has been carefully acquired using calibrated sensors. Present methods for acquiring such data are ad hoc, costly, and rarely satisfy the intended imagery needs.

The design and development of an instrumented sensor system suitable for employment on ground, and possibly also airborne, platforms is desired. The ideal system will be composed largely from commercial off the shelf (COTS) components and will be:

1) fully instrumented [using differential global positioning system (GPS), for example] to provide accurate, real-time position and orientation of the sensor and time of each acquisition;
2) composed of metrically accurate panchromatic, near and thermal infrared, as well as multispectral sensors;
3) capable of collecting individual frames or sequences at video rates;
4) calibrated for geometric and photometric accuracy;
5) mobile and able to operate outdoors under all weather conditions.

In addition, the prototype system would likely need to:

6) provide 10 gigabytes or more of local data storage;
7) include software to allow collection management and subsequent viewing and photogrammetric manipulation of collected data;
8) provide for easy dissemination of selected portions of the image archive including metadata in standard formats;
9) demonstrate feasibility of producing operational systems at low-cost.

PHASE I: Assess requirements for image acquisition from members of the synthetic environments and image understanding communities. Design a system that is capable of meeting those requirements to the maximum extent feasible. Analyze predicted performance. Deliver a specification and cost estimate for the ideal system.

PHASE II: Implement the system as designed. Demonstrate the performance by collecting data sets suitable for building three-dimensional models of buildings and other structures. Collect accurate ground truth data for each site through field surveys. Distribute data sets to interested users. Evaluate accuracy and operating characteristics of the implemented system.

PHASE III DUAL USE APPLICATIONS: There are many low-cost imaging devices for collecting imagery of the sort envisioned for the instrumented suite, but none combine metrically accurate sensors with high precision position and orientation data. The instrumented sensor has numerous applications for field data collection for accident investigation, architectural control, historical and archaeological archiving, and virtual reality modeling. The availability of instrumented sensor suites will not only fill an existing market for controlled image acquisition, but will also dramatically expand the market for analysis of visual data in many fields. Accurate geometric ground-truth data is vital for a variety of military purposes. Phase III application possibilities include construction of three-dimensional models for visualization of militarily significant structures, geometric reconstruction of field tests of military hardware, and acquisition of imagery and metadata to be used for training and testing of automatic image processing algorithms under controlled circumstances.

DARPA SB972-072 TITLE: Security Self-Checking Tools for the Global Command and Control System Leading Edge Services (GCCS-LES) Architecture

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop tools or mechanisms that provide the ability to probe, assess, and display the state of security and integrity of servers, applications, and data within the GCCS-LES architecture.

DESCRIPTION: Research and development is sought to enhance the security of the GCCS-LES architecture, which is being used for the Joint Task Force Advanced Technology Demonstration (JTF ATD), Joint Force Air Component Commander (JFACC) After Next Program, and other DARPA programs. Efforts may address self-probing of the system's security features and configuration, application and server status, and state of critical data objects. Self-probing tools must allow the ability to selectively control or shut down probes if the system state warrants it, and must protect themselves from unauthorized use or tampering. Tools must provide an appliation program interface (API) and should be pluggable into a common framework and graphical user interface (GUI). Approaches should be designed for scalability, extensibility to interoperate with new security features and tools, and evolvability as new or enhanced security APIs emerge. To the extent possible, approaches should be based on enhancing or extending commercially available security technology.

PHASE I: In detail, define the approach for self-probing, its semantics, design, functional and assurance approaches and limitations, and concepts for interoperation with commercial technology and extensibility. A tool API should be defined which fits into a common framework such as the one defined under DARPA SB972-078, "Open Architecture Security Tools."

PHASE II: Develop prototypes of one or more tools or approaches, and demonstrate them within the GCCS-LES architecture. Demonstration should include the ability of tool(s) to protect from unauthorized use and tampering. Experimentally evaluate their utility and benefits. Provide documentation of each tool or approach, including complete documentation of implementation results and test cases.

PHASE III DUAL USE APPLICATIONS: Tools for monitoring the health of a running system by continually probing its security and integrity should be of interest for many operational systems. The tools themselves have the potential to be commercialized as products. These tools will also be directly usable as part of a system security manager's toolkit in military systems such as the GCCS and in networks such as command center local area networks.

DARPA SB972-073 TITLE: Automated Synthetic Aperture Radar (SAR) Image Quality Assessment

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop, demonstrate, and evaluate techniques to automatically assess the quality of SAR images

DESCRIPTION: Advances in military and commercial SAR sensors have resulted in airborne and space-based systems that collect tremendous amounts of high-resolution detected SAR imagery that can be used for military surveillance and reconnaissance, as well as numerous commercial applications (terrain mapping, environmental monitoring, geological sensing, archeological investigations, etc.). The amount of data being collected from a single modern SAR platform far exceeds the capability for real-time review and assessment by humans; automated systems are being developed to collect, store, exploit, and disseminate SAR imagery. Unfortunately, system errors (e.g., calibration, hardware/software failures, communication errors, etc.) and processing errors (e.g., auxiliary data mismatch, mode mis-alignment, autofocusing, etc.) can result in the collection and automatic processing of SAR imagery that may be degraded, rendering it unsuitable for the additional processing stages. Without real-time image quality assessment the degradation in the SAR imagery could remain undetected for an unacceptable period of time resulting in expensive trouble shooting, missed collection opportunities, and expensive rerouting and re-tasking of sensor platforms. Fortunately, SAR systems are inherently coherent sensors and SAR image formation is a deterministic signal processing function; these features may provide the necessary information to allow the development of automated tools to assess the quality of SAR images. Quality features in the SAR image to be evaluated include, but are not limited to, dynamic range, contrast ratio, resolution, integrated sidelobe level, etc. This topic seeks proposals that will develop, demonstrate, and evaluate automated techniques to analyze the quality of formed SAR imagery in real-time, and provide a quality assessment of the imagery to guide follow-on processing, storage, and dissemination.

PHASE I: Design and develop a set of automated quality assessment tools that operate on SAR imagery and provide a real-time quality assessment of the formed imagery for follow-on processing.

PHASE II: Demonstrate proof-of-concept real-time SAR image quality assessment tool on collected SAR imagery. Provide a computational performance assessment which will allow for future extrapolation of the technique to images of various sizes and resolutions.

PHASE III DUAL USE APPLICATIONS: This technology is directly applicable to provide a valuable real-time quality assessment tool to support commercial airborne and space-based SAR imagery systems that perform terrain mapping, environmental monitoring, geological sensing, agricultural monitoring, and archeological investigations. This technology directly supports the military's requirements for the real-time exploitation of SAR imagery. Automatic SAR image quality assessment is required to ensure that future semi-automated and fully automated automatic target recognition (ATR) programs are processing useful data. Specific application platforms include the U-2, and the emerging Tier II+ Global Hawk and Tier III- Dark Star unmanned aerial vehicles

DARPA SB972-074 TITLE: Vehicle Motion Pattern Analysis

KEY TECHNOLOGY AREA: Sensors; Command, Control and Communications (C)
OBJECTIVE: Develop, demonstrate, and evaluate automated techniques for extracting purposeful temporal-spatial patterns from moving vehicle data.

DESCRIPTION: Detection of purposeful military movement is of critical importance to military decision-makers. Discernment of large, well-organized patterns in open spaces may be straightforward using conventional moving target indication (MTI) surveillance and reconnaissance sensors. However, detecting movement patterns of interest embedded within ambient traffic is far more difficult and is somewhat analogous to the engineering problem of extracting a signal from ambient noise. When a priori knowledge of the desired movement patterns is available, e.g., knowledge of doctrine or empirical movement data, then automated techniques similar to those used in signal processing or automatic target recognition may be exploited to detect the desired movement pattern; this is known as motion pattern analysis (MPA). The difficulty arises when a priori knowledge is limited, or non-existent, as will be the case in low intensity conflicts, e.g., counter-terrorist activity or certain peace-keeping missions. The problem is further exacerbated because little is known about ambient traffic. It is likely that this "clutter" will not be properly modeled as an ergotic stochastic process, as is the case with most signal-processing noise. However, even for the case of low intensity conflicts, purposeful movement patterns will occur due to physical constraints imposed by terrain, vehicle capabilities, and survivability. Anecdotal evidence suggests that purposeful motion patterns are manually discernible in the temporal-spatial record of MTI radar data with little or no a priori knowledge of movement patterns. This topic will pursue an inductive approach to MPA and seeks proposals that will develop techniques and tools to automatically identify and extract purposeful motion patterns from moving target data.

PHASE I: Using customer-supplied MTI data and user input (1) develop a mathematical formalism capturing current manual MPA techniques; (2) develop a description of candidate MPA features and extraction tools to detect and classify purposeful motion in ambient traffic; and, (3) develop a statistical description of ambient traffic clutter.

PHASE II: Develop a proof-of-concept MPA feature extractor and evaluate with customer-supplied, ground-truthed data.

PHASE III DUAL USE APPLICATIONS: This technology is applicable to a variety of commercial situations. The automated detection and identification of moving vehicle patterns will play a key role in the automated traffic flow monitoring and timely traffic re-routing in the "smart highways" of the future. In addition, inductive MPA techniques may be applied to the appropriate sensor data to automatically detect and classify migratory patterns of endangered species. Finally, sales patterns of individual or sector equities and commodities may be analogous to motion patterns; timely detection and classification of patterns would support timely decision-making in the business and financial markets. This technology directly supports the military's need for real-time Battlefield Awareness. MPA techniques will allow next generation airborne Intelligent, Surveillance and Reconnaissance (ISR) platforms, that are equipped with ground monitoring MTI sensors, to identify militarily purposeful movement on the battlefield. This information will supply the warfighter with real-time knowledge of enemy actions and intent. Specific application platforms include the Joint Surveillance and Attack Radar System (Joint STARS), the U-2, and the emerging Tier II+ Global Hawk.

DARPA SB972-075 TITLE: Open Architecture Security Tools

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop a set of standard application programming interfaces (APIs) for use in security tools and for integrating security functionality into systems. Modify a set of existing tools to conform to those interfaces. These interfaces will define standard messages, protocols, functionality, and semantics for modules that perform intrusion detection, diagnosis, automatic response, traffic filtering, access control, and so on. These interfaces will allow such security modules to be integrated into products and systems such as firewalls, network management tools, intrusion detection systems, routers, and operating systems.

DESCRIPTION: Research and development is sought leading to security systems and tools, such as firewalls and intrusion detection systems, that will allow for much greater ability to evolve to accept stronger security solutions than is possible with today's technology.

The use of standard interfaces allows the plug-and-play use of different forms of the same function; for example, modules implementing different types of intrusion detection analysis. Such interfaces will allow computing and network technology to include security functionality in a way that facilitates growth and evolution. For example, a firewall could use these standard interfaces to include one or more intrusion detection analysis modules, and these modules could later be replaced with better technology using the same interfaces. The interface should allow a module to be implemented in software or hardware. Standard interfaces facilitate reuse; for example, the same intrusion detection analysis modules could be used in network management tools and in intrusion detection systems. Standard interfaces also promote the emergence of niche vendors who supply the security modules, independent from the vendors who supply the systems that use the modules. In developing the interfaces, special attention must be paid to ensure that all currently known and envisioned forms of a security service or functionality can be made to use the interface.

Examples of modules that conform to these interfaces, and modified versions of existing systems that include these modules, will serve as reference implementations. These reference implementations will serve as guides for vendors and developers to use in understanding how to use the interfaces in their products and systems. We envision that these interfaces will be used analogously to the way cryptographic application programming interfaces (CAPIs) are currently being used for open implementations of systems that use cryptographic security services. These interfaces may be logically combined with CAPIs to form a more complete set of security service APIs. For example, the API called for under DARPA SB972-074, "Security Self-Checking Tools for the Global Command and Control System Leading Edge Services (GCCS-LES) Architecture" should fit into the general framework described here.

PHASE I: In detail, identify the interfaces to be defined, and the type of functionality and semantics that must be captured in the APIs. Define the process by which the APIs will be developed. Describe a plan for developing security modules that are conformant to the APIs and for modifying one or more existing security tools or systems (for example, firewalls or intrusion detection systems) so that they use the APIs and can accept the modules.

PHASE II: Develop prototypes of one or more security tools or systems that are conformant to the APIs developed in Phase I and that contain a collection of API-conformant security modules to implement their security functionality. In addition to the prototypes, produce documentation, as well as an experimental evaluation of the open architectural approach. Complete documentation of test cases and results must be delivered. The developer should work with the relevant bodies, players, and major users in the security industry to gain community acceptance of the APIs, modifying them where necessary to accommodate various requirements that arise in the process. In addition to conforming to the APIs, security modules should also be characterized according to their effectiveness, strength, and costs, including processing overhead, storage and bandwidth requirements, and management costs.

PHASE III DUAL USE APPLICATIONS: The development of standard interfaces to security functions and services will accelerate the introduction of such functions and services into products and systems. This will make it possible for vendors to design and build products that conform to the security interfaces without having to understand the security, or to implement the services themselves. Standard interfaces will lead to the emergence of vendors who supply a diverse set of security functions and services, conformant to the interfaces, with different strengths, effectiveness, and costs. Thus, such standard interfaces can help to establish new markets for security functionality. This will also make it more cost-effective to develop products and systems that use security, and will make it easier to upgrade to better security solutions as they become available. Effective software security systems are mandatory for military computing and networking programs.

DARPA SB972-076 TITLE: Real-Time Network Performance Diagnosis

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop methods for diagnosing network performance problems in real-time.

DESCRIPTION: Vendors today provide tools that show the network configuration and gross traffic measurements, but this is insufficient to discover anomalies with respect to reasonable behavior. The development of an object-oriented tool that can integrate three critical functions would make it possible to detect and correct problems within minutes. The functions are modeling, monitoring, and correlating. If this is done in an object-oriented fashion, and if it makes use of standard protocols such as simple network management protocol (SNMP), then the possibility of commercialization is great.

PHASE I: The first phase of the project is to develop a prototype system that includes interactive graphics for describing the components of a local area network (LAN) and its interconnections to other LANs or internetworks. The description must include hooks for modeling the expected behavior (bandwidth, latency, queuing, etc.), and for monitoring the runtime behavior, via traffic probes, SNMP, remote monitoring, load measurements, etc. The modeled and observed behaviors must be displayed in a lucid manner that assists analysts and operators, and can be easily modified. The LAN descriptions must be modifiable and composable in a simple fashion.

PHASE II: Make the tool available on commercially available platforms and add diagnosis capability. Take measurements of runtime traffic, both the offered traffic at end systems and the observed traffic at routers, firewalls, gateways, etc., and compare them to what the models predict, for example, if the system should be able to identify machines that have an abnormal number of ethernet collisions with respect to other machines on the network. Routers that drop too many packets in comparison with the offered traffic should be identifiable automatically.

PHASE III DUAL USE APPLICATIONS: This would be a valuable tool for any organization that has a growing set of LANs with internal connectivity. Internet service providers could use the tool for diagnosing their service level and inter-provider service agreements. Network management firms could deploy it at their customer's sites, and provide superior maintenance capability at lower cost. This tool will be used in a military tactical environment to diagnose networking problem.

DARPA SB972-077 TITLE: Accelerating Network Protocols

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: To maximize the throughput of internet protocols by utilizing detailed knowledge of the protocol semantics.

DESCRIPTION: Internet protocols are written in a layered fashion that provide simple interfaces and limited visibility into the internal state of each layer. However, it is possible for intermediate processing elements in the network to take advantage of knowledge of the protocols and observed real-time behavior to improve observed performance. For example, a protocol that provides end-to-end reliability might be improved if the network kept some memory of delivered data and could respond to retransmission requests without communicating with the actual sender.

PHASE I: A report on which Internet protocols could benefit from acceleration techniques, and descriptions of techniques. Simulation results demonstrating expected improvements in at least three protocols.

PHASE II: The Phase II will include mathematical models and runtime results extending the analysis in Phase I, and protocols ready for deployment in network elements (e.g., firewalls, gateways, routers, switches) with documentation about expected performance gains.

PHASE III DUAL USE APPLICATIONS: There is potential for commercial products for workstations, web servers, and router software that provide greater use of existing network facilities by protocol accelerators. Multicast sessions, in particular, can be tuned to current network performance to take advantage of buffering, caching, fast retransmits, and fast acknowledgements. Military operations would benefit from increased performance on military equipment.

DARPA SB972-078 TITLE: Multilevel Performance Frameworks and Tools for High Performance Systems

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Creation or robust implementation of performance methods and tools for modeling, measurement, analysis and evaluation of parallel and networked systems, and the applications executing on such systems. Special emphasis will be placed on frameworks and tools that support large scale parallel systems and those that can support (heterogeneous) distributed systems and enable understanding and predicting the behavior of such systems.

DESCRIPTION: Research and development leading to prototype frameworks and tools supporting the development needs of high performance computing and communications systems, hardware as well as software is sought. Substantial improvements in the current tools and methods are needed to measure, model, and analyze computer systems, at all levels (from the application, to the software, to the hardware level), and to develop a performance framework to permit analysis of the entire system. Efforts may encompass the development of novel performance frameworks and tools, or the creation of robust implementations of existing prototypes, geared to address the needs for measurement and analysis of systems computational requirements, as well as communication and I/O requirements. Such frameworks and tools should include, but are not limited to: multilevel measurement and abstraction capabilities, multilevel model validation and integration, functional specification methods, performance specification languages, and performance analysis visualization tools. Ability to use the tools for collecting measurements on existing hardware and software platforms and extrapolating to analysis and prediction of performance of future hardware and software designs is considered important.

PHASE I: In detail, define the methods and the tools to be developed, the performance framework architecture, the technical approaches, interfaces, tradeoffs, and enhancements over current approaches or existing tools, together with feasibility analysis, identifying the testbed systems, and providing measurable criteria of the validity and success of the approach.

PHASE II: Prototype, develop, demonstrate, evaluate and deliver performance frameworks and integrated support environments for analysis and prediction of the performance of hardware and software systems, including numerically intensive applications, along with evidence that demonstrates the enhancements made by this work, and providing the associated documentation for using such tools.

PHASE III DUAL USE APPLICATIONS: Lack of adequate multilevel performance analysis and prediction capabilities has hampered building effective high performance parallel and distributed systems whose behavior and design tradeoffs are well understood. The present effort can contribute towards creating tools that allow the possiblitiy to skip generations of prototypes of such systems, and understanding their behavior as at the range of large numbers of processors and large applications, which will aid and expedite the development of applications, software, and parallel and distributed high performance machines critical to DoD's needs.

DARPA SB972-079 TITLE: Mobile Oceanographic Sensor Suite

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a suite of low-cost mobile oceanographic sensors that can be used by tactical platforms for on-site environmental characterization of the littoral. Such sensors would provide global knowledge of acoustic propagation, radically enhancing acoustic surveillance and weapon homing.

DESCRIPTION: Presently, tactical platforms possess limited environmental sensors onboard, or are easily available for deployment in-situ. Since the littoral is highly variable, both temporally and spatially, a need for local rapid environmental measurements is apparent. The resultant data set will enable the platforms to make more efficient use of sensor suites to perform assigned missions. The sensor suite will supply the needed cornerstone for underwater scene understanding.

PHASE I: Develop a set of requirements that will identify existing sensors and highlight those areas where advanced concepts are required. Also include the development of a concept of operations to make efficient use of the sensors over large areas of the littoral and the integration into a collaborative approach among all platforms with respect to mission accomplishment.

PHASE II: Design a prototype mobile system containing a suite of environmental measurement devices that can assist tactical platforms in optimizing the use of their sensors in littoral regions of interest. The design should address the means to communicate the collected data to the tactical platforms so that a collaborative effort to mission execution can be effected.

PHASE III DUAL USE APPLICATIONS: The resultant mobile measuring devices will be of use in the oceanographic fisheries and petroleum industries to determine the character of the water column, and the geological features that support underwater commerce, and will provide the oceanographic community an advanced suite of sensors on a convenient platform to rapidly collect oceanographic data (e.g., physical, chemical, geoacoustic). Such data would enhance macroscopic weather modeling and prediction by providing coherence studies of surface and subsurface phenomenology. From a military standpoint, this effort will characterize the in-situ water column to allow for the calculation of sensor performance predictions in the local environment.

DARPA SB972-080 TITLE: Multi-Modal Interface for Command and Control of Military Robots

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: Creation and evaluation of multi-modal human/robot interfaces enabling command and control of remote robotic vehicles.

DESCRIPTION: Research and development leading to interfaces that enable users to receive information from and send commands to remote robotic vehicles while the users are in field or combat environments. DARPA seeks an interface more compact and employing more sensor modalities than the interface developed on the Unmanned Groud Vehicle. Modalities of interest include speech, simplified keyboard, laser pointer, and others.

PHASE I: Develop and demonstrate a multi-modal human/robot interface capable of recognizing inputs from a single user for command and control of robotic vehicles.

PHASE II: Develop, demonstrate, and deliver a multi-modal human/robot interface capable of recognizing inputs from multiple users in field and combat settings. Conduct tests to quantify performance of interface. Complete documentation of test procedures, cases, and results must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of multi-modal interfaces for robot control will expand markets for robots, particularly field robots, and mobility aids for the disabled. The ability to receive and send commands to remote robotic vehicles is mandatory in combat environments.

DARPA SB972-081 TITLE: Tactical Grade Inertial Navigation System (INS) using Microelectromechanical Sensor (MEMS) Technology

KEY TECHNOLOGY AREA: Sensors; Electronics

OBJECTIVE: Exploit the MEMS technology base to develop a tactical grade INS featuring low power, small size, and light weight.

DESCRIPTION: Conduct research and development leading to the demonstration of an INS. Current MEMS technology includes miniature accelerometers and gyros, but not the integration of the two into a useful INS. The goals for this effort are: 1) Demonstrate solid state based (i.e., silicon) MEMS fabricated gyros (angle rate sensor) and accelerometers (linear velocity rate sensor) improved to tactical grade (1.0 to 10.0 degree/hour angle rate bias and 500 μg bias on acceleration); 2) Integrate these sensors into a low power (less than 1 Watt) and very small (less than 10 cubic inches with variable form factor per application) INS; and, 3) Demonstrate a complete breadboard system using Personal Computer Memory Card International Association (PCMCIA) data/bus interface standard.

PHASE I: Identify MEMS sensors and system design, and provide first level INS design mechanical layout. Identify navigation software approach.

PHASE II: Integrate sensors to inertial block and implement INS software on a system processor. Perform breadboard laboratory demonstration of a complete system with option for field demonstration.

PHASE III DUAL USE APPLICATIONS: A broad range of applications exists in the area of commercial navigation/dead reckoning systems to augment GPS receivers. These systems are currently limited by GPS outage, particularly in urban environments. Other areas exist in embedded inertial rate sensors for automotive applications (e.g., anti-spin out sensor, active suspension), train control, and commercial drilling applications. From a military standpoint, small size and low power enable man portability and use when GPS signals are obscured, e.g., for operations in buildings, under multiple tree canopy, etc. These attributes, along with low cost, also are appropriate for guided munitions and small unmanned air vehicles.

DARPA SB972-082 TITLE: Robotic Mechanisms Capable of Attaching Themselves to Moving Ground Vehicles

KEY TECHNOLOGY AREA: Ground Vehicles

OBJECTIVE: Design, development, and validation of robotic mechanisms capable of attaching themselves to moving ground vehicles.

DESCRIPTION: Research and development of robotic mechanisms capable of detecting and localizing moving ground vehicles, and attaching themselves to those vehicles as they travel near the mechanism. Evaluation of mechanism design must quantify mass, volume, power, and expected cost of manufacture. Evaluation of mechanism performance must include (but need not be limited to) tests with independent variables of vehicle type and vehicle speed, and with dependent variable of success of attachment.

PHASE I: Define, design, and simulate robotic mechanisms exhibiting the self-mobility required to attach themselves to moving ground vehicles.

PHASE II: Fabricate and evaluate self-mobile robotic mechanisms capable of attaching themselves to moving ground vehicles. Documentation of tests must be delivered, including information on the test methods and test results.

PHASE III DUAL USE APPLICATIONS: The development of miniaturized, low-cost robotic mechanisms, capable of attaching themselves to moving vehicles, will expand markets for material handling robots that perform loading and unloading operations, medical robots that handle surgical tools, and manufacturing robots that manipulate parts. This technology will be used by military troops to track and target enemy vehicles.

DARPA SB972-083 TITLE: Man Portable Smoke Generator

KEY TECHNOLOGY AREA: Manpower, Personnel and Training; Sensors

OBJECTIVE: Provide a man portable smoke generator capable of rapidly dispensing a non-toxic, environmentally friendly screening smoke transparent to long wavelength infrared (LWIR) viewing devices, but opaque to visible through short wavelength infrared (SWIR), in support of small unit combat and confrontational non-combat operations.

DESCRIPTION: A man portable smoke generating system capable of rapidly generating a screening smoke employing fog oil or other appropriate petroleum or vegetable agents is envisioned. A back pack tank holding 3-5 gallons of agent is desired. The selected screening agent should produce a rapid screen transparent to LWIR viewing devices. It is desired that the screening agent be projected forward from the operator under the operator's control. The system should be capable of dispensing a 400 square meter cloud in under 45 seconds; the cloud should persist for at least 20 minutes in ideal (no wind) conditions.

PHASE I: Contractors will provide two prototype systems capable of dispensing standard Army fog oil for test and demonstration of suitability and capability. Other potential agents should be identified, but should be non-toxic and environmentally friendly.

PHASE II: Contractors will modify their prototype systems to correct functional and other deficiencies identified during Phase I. A total of six systems configured for field test and in a near production ready configuration will be provided. During this phase, additional agents other than fog oil will be tested. These additional agents will include those recommended by the contractor and others that may be selected by DARPA in consultation with the Project Manager, Smoke/Obscurants, at Aberdeen Proving Ground, MD.

PHASE III DUAL USE APPLICATIONS: Law enforcement agencies frequently encounter confrontational and potentially violent situations where denying vision to engaged persons not equipped with thermal viewers would provide a powerful tool for a non-violent resolution. Riot control, hostage rescue, and apprehension of entrenched violators are examples. Military troops need portable smoke generators to provide cover on the battlefield.

DARPA SB972-084 TITLE: Two-Dimensional In-Plane Thermal Deformation Measurement for Large Area Substrates

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop processes and equipment that allow high-speed, automated scanning and analysis of large area electronic substrates to determine in-plane deformation under temperature cycling.

DESCRIPTION: Large area manufacturing processes for high performance/low-cost electronics systems are being developed for batch fabrication of multichip module (MCM) and high density laminate substrates. This approach raises reliability questions concerning differential thermal expansion between substrates and components during fabrication, test, and operation. The deleterious affects of sheer stresses, creep, solder joint fracture, and delamination need to be countered through the gathering of comprehensive empirical data, which will aid in materials selection, improving component layout, and will provide information towards completing reliability models under development. As substrates continue to get thinner to save weight and reduce size, circuit density will increase, leading to greater thermo-mechanical interactions between the components and the substrate. A machine of moderate cost enabling rapid acquisition and analysis of warpage data for large area bare and populated electronic substrates is needed to address reliability concerns for military, automotive, and industrial electronics.

PHASE I: Examine sensors and data acquisition methods (including visible, infrared (IR), and shadow moire) to determine most effective techniques for broad warpage measurements. Develop breadboard candidate approaches to aid in developing an engineering prototype for fabrication in Phase II. Develop sample preparation procedures and provide experimental evidence of analysis sensitivity, reproducibility, and speed.

PHASE II: Construct prototype based on design from Phase I. Capabilities must include large area substrates at least 12" x 12", reflow soldering simulation temperatures up to 300°C, and thermal cycling temperatures ranging from -55°C to +125°C. Enhancements such as thermal shock simulation and high speed data analysis shall be investigated.

PHASE III DUAL USE APPLICATIONS: Applications are abundant in the automotive, industrial and telecommunications markets. Electronics reliability requirements for these markets are often just as stringent as military requirements. Thermally efficient designs, enhanced manufacturing yields, and increased reliability are available through the development of this inspection/analysis tool. Commercial designs, especially in the Personal Computer Memory Card International Association (PCMCIA) circuit card market, are seeking to pack chips in a much higher density on an extremely thin substrate, leading to reliability problems from stress buildup between the chips and substrate. Smaller and smaller telecommunications devices are built upon thinner and thinner substrates, leading to warpage problems. These products are typically fabricated and assembled while in a large panel form, and the stresses to individual coupons on a large panel during the manufacturing process can be better understood through the use of the proposed tool. The capability to determine high stress areas through warpage mapping is highly desirable in the commercial arena, as well as the military community. This program has applications in all military electronic systems, including missile guidance and control, and all of the support equipment utilized to service this equipment. It would be utilized in both the manufacturing of circuit boards and large multi-layer components, and in servicing of the manufactured items. The same use is present for commercial electronics utilized in TV and satellite systems as well as the computer industry.

REFERENCES:

1) Michael R. Stiteler, Charles Ume, and Brian Leutz, "In-Process Board Warpage Measurement in a Lab Scale Wave Solder Oven," 46th Electronics Components and Technology Conference Proceedings, Orlando, FL, May 1996.
2) F.P. Chiang, "Moire Methods of Strain Analysis," Chap. 6, Manual of Experimental Stress Analysts, 3rd ed., A.S. Kobayashi, Ed., Society of Experimental Stress Analysis, Bookfield Center, CT 1978.
3) I.G. Zewi, I.M. Daniel, and J.T. Gotro, "Residual Stresses and Warpage in Woven-Glass/Epoxy Laminates," Society of Experimental Mechanics Fall Conference Proceedings, Grenelefe, FL, November 1985.
4) Various publications available from the Optomechanics Research Lab at Binghamton University Internet site: http://omrl.me.binghamton.edu/

DARPA SB972-085 TITLE: In-Situ Optical Fiber Stress Profilometer

KEY TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: There is a requirement for new and innovative approaches to measure the stress profile along a length of optical fiber. The objective is to determine the best approach or approaches, demonstrate their practicality, and build a prototype stress profilometer.

DESCRIPTION: The use of optical fiber data links in missile systems requires that the fiber deployment be a smooth rapid process during missile flight. If there is a flaw in the winding of the fiber on the deployment bobbin the fiber is vulnerable to breakage. One of the critical winding parameters is the stress profile. In order to validate winding models it is necessary to determine the stress profile on a wound optical fiber bobbin, preferably with a system that requires only access to one end of the fiber. Optical time delay reflectometers (OTDR) can operate this way, but their output is completely insensitive to the stress profile. Several techniques such as Brillouin scattering, coherent interferometry, and polarization interferometry have been proposed and investigated in the past. The overall technical requirements are a 1% measurement capability over at least ten kilometer fiber lengths for a typical stress of 108 N/m2.

PHASE I: Review stress mechanisms in optical fibers and determine the optical effects expected to provide the data signals. Study fabrication methods and fiber architectures for making special test fibers with distance markers and/or other internal fiber structures to provide a signal output in the event that intrinsic stress effects are found to be inadequate for use. Perform laboratory tests to verify operation of the candidate techniques, and perform a preliminary design of a prototype stress profilometer.

PHASE II: Perform advanced laboratory mtests and demonstrations of selected techniques. Perform the detailed design of the stress profilometer, procure components, assemble, integrate, test, calibrate and deliver the hardware system and all documentation.

COMMERCIAL POTENTIAL: This work would have significant impact in the commercial optical fiber communications fields, as it would allow remote stress profile measurements to pinpoint locations where optical fibers may be subject to breakage, thus allowing corrective action prior to breakage so that the comunications systems are not disrupted.

REFERENCES:
1. "Tensile Strain Dependence of Brillouin frequency Shift in Silica Optical Fibers," T. Horiguchi, T. Kurashima, anf M Tateda, Proc. IEEE #1041-1135/89/0500-0107 (1989).
2. "A Differential Polarization Interferometer for Measurement of Residual Stress in Optical Fiber Bobbins," J. L. Johnson, Proc. of Workshop on Fiber Optics for Missile Applications, May 7-8 1996, Redstone Arsenal, AL.

DARPA SB972-086 TITLE: Wideband Optical Receivers

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

OBJECTIVE: Develop high-power handling, highly linear wideband optical detectors capable of efficient conversion of modulated optical signals to analog radio frequency (RF).

DESCRIPTION: Research and development leading to wideband detector receivers capable of highly linear/high efficiency conversion of modulated optical carrier-based signals from optical waveguides to RF carrier-based signals. Detectors must be capable of handling high optical power levels (>20 milliwatts) and remain linear. Detector receivers must be capable of wideband operation from 20-100 GHz without distortion. Optical wavelengths of interest are 1.3 and 1.55 microns.

PHASE I: Develop tradeoff design approaches and wideband detector receivers with limited breadboarding.

PHASE II: Implement most promising detector design and incorporate into a link for evaluation.

PHASE III DUAL USE APPLICATIONS: This development has commercial applications in satellite receivers, television distribution systems, cellular radio, microwave radio relay, collision avoidance systems, and remote sensing. Military applications include large phased antennas, electronic warfare receivers, or signal intelligence platforms.

DARPA SB972-087 TITLE: Continuous Apertures

KEY TECHNOLOGY AREA: Electronic Warfare; Sensors; Command, Control and Communications (C3)

OBJECTIVE: Develop novel designs, techniques, and structures to synthesize apertures capable of efficient operation over broad frequency ranges and functions.

DESCRIPTION: Current antenna aperture designs are usually narrowband or, at best, optimized for a narrow set of frequencies, whether they be phased arrays or single radiators. Single point designs are, therefore, narrowly focussed, application specific and, thus, expensive. If an arbitrary aperture could be synthesized from a continuum (or near continuum) of radiators, the overall system cost could be greatly reduced. It is the purpose of this effort to research novel electromagnetic materials, optoelectronics, photonics, superconductivity, photonic bandgap structures, and antenna synthesis techniques to develop antenna building blocks such that arbitrary antenna structures and frequencies of operation can be synthesized. Measures of success are that the resulting synthesized apertures function nearly equal, or equal to, single point designs.

PHASE I: Define a design in detail, demonstrate potential by analysis/simulation and limited breadboarding.

PHASE II: Synthesize several apertures from a "continuum" of aperture functions and demonstrate performance compared to conventional antenna systems.

PHASE III DUAL USE APPLICATIONS: The development of continuous aperture technology will enable cost-effective implementation of wide frequency range apertures for commercial systems, e.g., cellular radio, direct broadcast TV, and mobile satcom. Antennas will become a fraction of their current cost because of the elimination of the need for specialized designs. Military applications include phased array antenna systems for ground, air, or space platforms; electronic warfare; signal intelligence; and satellite communications.

DARPA SB972-088 Title: Technologies for the Detection and Characterization of Deeply Buried Targets

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Concept development and prototype design specifications for technologies which enable detection and characterization of deeply buried targets.

DESCRIPTION: Nuclear, biological, and chemical (NBC) materials production, storage, and operations facilities may be located in underground facilities (UGF). The construction of these targets ranges from near surface targets ("cut and cover") to deeply buried targets (DBT) to hardened deeply buried targets (HDBT) whose only access points are reached via tunnels. In addition to the actual destruction or disablement of these threats, their negation requires the execution of three missions: broad area detection and identification, functional characterization (to include determination of UGF purpose, materials contents, operational status, etc.), and physical characterization (3-D geographic location, size, construction features, protective measures, security features, support equipment such as HVAC and prime power, etc.). The targets' location in denied areas imposes additional requirements of covertness and/or long standoff range for these missions.

DARPA is soliciting proposals for sensor technologies which support the broad area detection and characterization functions. Candidate technologies should support reasonable operational employment concepts, such as, use by special operations forces, unattended ground sensors, low observable unmanned air/ground vehicles, or stand-off airborne platforms.

PHASE I: Provide a sensor technology feasibility assessment and concept design. Include preliminary performance predictions/results and a development roadmap for the recommended technologies. Indicate how devices fit into operational employment concepts. Provide estimates of unit cost and producibility, along with requirements for packaging, prime power, processing, and communications.

PHASE II: Provide detailed device designs. Develop breadboard component hardware which can lead to a fieldable system design. Perform field test demonstration of devices.

PHASE III DUAL USE APPLICATIONS: Successful conclusion of this development effort may lead to important sensing capabilities for civil defense, disaster response, geological survey, mining, and environmental air/water quality monitoring. From a military standpoint, insertion of this technology on a number of platforms supports a broad spectrum of counter-proliferation concerns.

DARPA SB972-089 TITLE: Instrumentation for Nanostructure Analysis

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

OBJECTIVE: Develop the capability to analyze nanostructures with diagnostics or characterization tools to enable advanced microelectronics and nanoelectronics in the sub-50 nm regime.

DESCRIPTION: As critical electronic device dimensions go substantially into the sub-100 nm regime, characterization and diagnostic tools will have increasing difficulty in detecting defects and impurities, and performing the detailed material analysis, and analysis of the electronic behavior which is required in this size regime. This topic seeks to address this area through further research, development, and integration of microanalysis instrumentation into advanced electronics which have resulted from DoD and other basic research investments.

One area is the ability to measure elements having a high ionization potential including hydrogen, carbon, nitrogen, oxygen, and fluorine. However, these elements are very difficult to measure quantitatively at the needed resolution. Capabilities are needed which allow sub-50 nm resolution, and quantitative measurements of these elements with very high efficiency, sensitivity, and selectivity. Very important, also, at this reduced scale is that one needs to examine the electronic behavior, both spatially and temporally, using such tools as nanoprobes. Another area, for example, is to explore the limits of tools such as the microcalorimeter for x-ray microanalysis. X-ray spectroscopy is one of the most sensitive non-destructive elemental analysis techniques. It can furnish the elemental composition of an array of structures. Chemical identification and classification of particles in the submicron regime is one of the major problems facing processing of advanced electronic devices.

As we progress to small electronic device structures and extremely high density circuitry, the performance requirements for micro- and nano-analysis equipment are pushed beyond the current equipment limits. As next generation devices become available with critical feature sizes well below 100 and even 50-nm, the proper analytical tools need to be available.

PHASE I: Develop detailed designs and show feasibility of critical concepts for nanocharacterization.

PHASE II: Develop and demonstrate complete prototype instrumentation and demonstrate that it meets goals and specifications originally targeted. Successful proto-typing in Phase II would increase the probability of a Phase III.

PHASE III DUAL USE APPLICATIONS: More cost-effective growth and processing of advanced material and device structures; reliable electronic and optoelectronic device structures; improved high frequency and low power electronics; quantum well detectors and emitters; process and device structure verification. Currently, military and civilian electronic systems can be made of devices which have elements and structures so small that it is virtually impossible to test the extremely high device performance with standard instrumentation. The Phase III program seeks to overcome the limitations in characterization and diagnostics such that advanced ultra small devices may be exploited to their fullest potential. Making the appropriate tools available to the microelectronics industry would greatly benefit the development of future DoD advanced electronics, magnetics, optics, and micro-mechanical systems.

DARPA SB972-090 TITLE: Spatial-Spectral Automatic Target Recognition (ATR)

KEY TECHNOLOGY AREA: Exploratory Development

OBJECTIVE: Develop and test algorithms and systems to support airborne, real-time automatic target detection and identification using combined EO/IR spatial and spectral discriminants.

DESCRIPTION: Automatic target recognition has long been a required military capability; results of Desert Storm reinforce the need to automatically detect and identify military targets and to locate the targets with sufficient accuracy to perform precision strikes. The requirements to overcome the effects of camouflage, concealment, and deception (CC&D) and to detect targets in deep hide have added to the difficulty of detecting and identifying time critical targets. Spectral-based (multispectral and hyperspectral) imaging sensor systems, operating in conjunction with other sensors, offer the potential to automatically detect military targets with high probabilities of detection and associated low false alarm rates, over limited search areas, and to support man-in-the-loop or automatic weapon delivery. Much research has been performed in spatial ATR. This effort seeks to optimally combine results from this previous spatial-based ATR work with emerging spectral-based discrimination techniques.

PHASE I: Identify novel concepts and approaches for spatial-spectral ATR. Quantify ATR performance within the spatial-spectral trade space and compare results to classical ATR approaches. Develop a system concept for applying the ATR approaches to current or planned airborne spectral imaging sensor systems. Define Phase II approach.

PHASE II: Demonstrate the selected approaches and algorithms in a real-time, automated processing environment supporting a civilian or military remote sensing system.

PHASE III DUAL USE APPLICATIONS: Spatial-spectral ATR systems may be used by other government agencies and the civilian sector for environmental and remote spectral sensing applications.

REFERENCES:
Schwartz, Craig R., et al., "Thermal multispectral detection of military vehicles in vegetated and desert backgrounds," Proceedings of the SPIE, Vol. 2742-30, Orlando, FL, April 1996.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; reduced signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extremes temperature environments; water depth and atmosphere pressure proof; transportable by aircraft, ship and submarine, and deplorable by airdrop; LLPI/LPD jam resistant C3I, electronic warfare capable of disruption and deception; near real-time surveillance, intelligence and mission planning; highly lethal and destructive; low energy/power requirements; and compatible with conventional force systems. USSOCOM is seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent a portion of the problems encountered by SOF in fulfilling its mission.

USSOCOM invites the small business community to **send proposals directly to the following address**:

United States Special Operations Command
Attn: SOAC-KB/SBIR Program, Topic No. SOCOM 97-00__
2408 Florida Keys Avenue, 2nd Floor
MacDill Air Force Base, Florida 33621-5316

The proposals will be distributed to the appropriate technical office(s) for evaluation. **Inquires of a general nature or questions concerning the administration of the SBIR program should be addressed to :**

United States Special Operations Command
Attn: SOSB/ Ms. Karen L. Pera
7701 Tampa Point Blvd.
MacDill Air Force Base, Florida 33621-5316
Tel (813) 828-9491
Fax (813) 828-9488
E Mail perakl@hqsocom.af.mil

General/routine correspondence being dispatched by overnight delivery should use the following address:

United States Special Operations Command
ATTN: SOSB/Karen L. Pera
Building 143
2600 Pink Flamingo Avenue
MacDill AFB, Florida 33621-5316

USSOCOM has identified 5 technical topics for the FY 97.2 solicitation to be released to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

Firms are encouraged to submit a proposal for an optional task which would be performed during the period between Phase I completion and Phase II contract award. The optional task provides the opportunity to reduce the gap between Phase I and II. The maximum amount of SBIR funding used for an USSOCOM Phase I award is $100,000. Proposals that include the option task shall not exceed $70,000 for Phase I and $30,000 for Phase I Option. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and not be included in the basic Phase I proposal page limitation. The basic Phase I proposal shall be evaluated exclusive of the option task and must be proposed and priced separately. The option portion of the proposal shall not exceed 10 pages, not exceed $30,000, not exceed three months in duration, and be evaluated using the same evaluation criteria as Phase I proposals. The transition option work shall be included as an option in the Phase I contract and evaluated for USSOCOM unilateral exercise at any time after Phase I award through the conclusion of the basic Phase I contract. Exercise of any option shall be at the sole discretion of USSOCOM and shall not obligate USSOCOM to make a Phase II award.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result , USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals are deemed superior, or it may fund no proposals in a topic area.

USSOCOM
FY 1997 SBIR TOPIC INDEX

SUBJECT/WORD INDEX TO THE SOCOM SBIR SOLICITATION

USSOCOM

FY 97.2 TOPIC DESCRIPTIONS

SOCOM 97-004 TITLE: Ultra Low Power SATCOM Receiver

KEY TECHNOLOGY AREA: C3/Electronics

OBJECTIVE: Design, develop and field test a SATCOM receiver that has the following characteristics:

1. Operates in one of the current or near future SATCOM bands
2. Needs a very small antenna with a large field of view
3. Uses a minimal amount of power
4. Maintains near 100% availability
5. Is frequency agile
6. Will support at least a 1200 baud data rate with a low error rate
7. Can operate in the presence of strong, nearby, inband transmitters
8. Can operate with Military and/or Commercial Satellite Systems
9. Small

DESCRIPTION: Design and demonstrate a small size, low power, modest cost receiver that is capable of worldwide SATCOM reception for receipt of information in austere environments. The receiver must be capable of operation on a small battery for more than 30 days with near 100% availability. The receiver must operate on the same frequency as several other units. It must support an addressable protocol. It can be remotely tuned to one of several frequencies in the SATCOM band. It must contain enough firmware that it can find a command data stream if it becomes lost (off frequency). The design of the receiver must be such that a very small antenna can be used (processing gain, error correction etc.). The receiver must be able to operate in the presence of nearby in-band transmitters (full duplex mode). The unit must be rugged and able to withstand physical extremes of temperature and humidity.

PHASE I: Perform systems analysis of current and future SATCOM systems that may be used for remote autonomous surveillance systems. Perform design trades of cost, size, power consumption, operational utility that optimize the receiver design. Propose a design that will use a minimum of power while maintaining a maximum availability and meet all of the above requirements.

PHASE II: Build a prototype(s) receiver (brassboard) that demonstrates the operation of the unit. Do on-the-air testing to provide confidence that the receiver will support the remote surveillance systems requirements. Develop the communications protocol firmware that will allow multiple receivers on the same channel. Do detailed cost analysis of unit production price for various quantities.

PHASE III DUAL USE APPLICATIONS: Advances the current trend in global wireless communications. Provides commercial application as worldwide pager. Military application as a secure voice/data receiver for extended field use in logistically austere environments.

SOCOM 97-005 TITLE: Helmsman's Neck Collar

KEY TECHNOLOGY AREA: Biomedical/Human Systems Interface

OBJECTIVE: Develop an advanced neck support collar or new components for existing systems to provide Special Operations Force (SOF) Helmsman/crew members with a device to decrease neck muscle fatigue caused by the dynamic response of the crew members' heads and necks during extended, high speed boat operations.

DESCRIPTION: The operation of new high speed surface craft accompanied by the use of new night vision goggles and helmet mounted display systems is increasing the weight supported by the heads and necks of the Special Operations Combatant Craft Crew Members (CCCM). This increased weight results in higher level of neck muscle fatigue during missions. A neck collar will provide the CCCM with added neck support to decrease neck muscle fatigue when operating at high speeds on rough seas. The neck collar will include oral-inflation and deflation (if an inflatable system is selected), ballistic neck protection equivalent to current body armor systems, and face-up in the water life preserving properties. Technologies related to this requirement include inflatable life jackets, head and neck travel pillows, ballistic armor vests and medical cervical collars.

PHASE I: Characterize accelerations associated with high speed boat operations in sea states 1-3. Investigate technologies and devices suitable for use in a Helmsman's Neck Collar, and identify a test protocol for this device.

PHASE II: Develop and test prototype Helmsman's Neck Collar.

PHASE III DUAL USE APPLICATIONS: Maritime applications in commercial recreational and race boating industry and military high speed boat operations to decrease neck muscle fatigue for boat operators and crews.

REFERENCES: Human and Manikin Head/Neck Response to + Gz Acceleration When Encumbered by Helmets of Various Weights: John R. Buhrman, Chris E. Perry; Aerospace Medical Association, Alexandria, VA; Aviation, Space, and Environmental Medicine, December 1994.

SOCOM 97-006 TITLE: Man Personal Dual Band Miniature Beacon (Active/Passive/IFF)

KEY TECHNOLOGY AREA: C3/Electronics/Sensors

OBJECTIVE: Build and provide a light weight, small (1.5"X3"X5" estimated size) dual band beacon (I&K band).

DESCRIPTION: SOF tactical and support aircraft require navigational aids to assist in locating and positively identifying austere assault zones, verify enroute check points, update inertial navigation systems and require positive reference points for close air support operations to prevent fratricide. Capitalize on a Phase I Small Business Initiative Research (SBIR) project sponsored by Army CECOM. As a part of that SBIR, a small business designed and built a low power I-Band beacon transponder that was successfully tested with the AC-130 H and U model gun ship. The SBIR beacon has single, double, triple pulse and an active pulse (passive for the aircraft) capabilities. The proposal will take this project an additional step further to integrate a K-band transponder into the existing I-band module, incorporate agile automatic gain control (AGC) and a smart receiver. Adding a K-band transponder module will enhance aircraft radar interrogation capability. Investigate the potential and incorporate a RS-232 data interface, GPS chip and a reprogramable select call (SELCAL) code for information friend or foe (IFF) mode of operation. The proposed beacon will automatically detect the proper interrogation band (I or K) and respond in kind with a predetermined or selected code pulse. Automatically adjusts its internal AGC to respond to weak as well as strong interrogations (multiple aircraft at varying ranges). Has a capability to transmit active pules (no interrogations from the aircraft required) to limit high powered emissions from aircraft radar. Can act as an IFF with a reprogrammable SELCAL and global positioning system (GPS) location data displayed on a standard military weather radar set (APN-59) and fire control radar (APQ-150 and APQ-180). As a goal, operate 24 hours on a standard 9 volt or AA type battery.

PHASE I: Determine feasibility of meeting desired criteria based on review of past work, assessment of current technology, and an initial design concept.

PHASE II: Design, build and bench test prototype system(s). Field test most promising alternative. Prepare manufacturing cost analysis.

PHASE III DUAL USE APPLICATION: The potential for commercialization of the outputs from this program is high. The military employs a variety of pulsed frequency sources to perform functions such as aircraft tracking, missile tracking, personnel detection and off-set target designation to name just a few. In most of these functions, the technology employed in the systems still rely on the use of magnetron or vacuum tube triodes as the RF signal generation sources. This older form of technology requires and dissipates high power, requires long warm-up times to obtain frequency stability, and has a short mean time between failure. This program intends to make available high peak power solid state sources that consume less power, have a quick frequency stability set-on time, are of small size, lightweight and extremely reliable. Thus, this program will provide additive capabilities, as well as, improve cost and effectiveness of present capabilities. Another advantage of the desired technology is immediate compatibility with existing radar systems. Immediate military applications for SOF include, in all weather day/night conditions, assisting SOF aviation platforms to precisely locate austere assault zones and infiltration/exfiltration points, providing en-route aviation navigational aids, and preventing fratricide during close air support and maritime operations through positive identification and geolocation. More general military applications include providing positive identification and accurate location for combat search and rescue, joint and coalition operations, and humanitarian relief. Potential commercial applications include enhancing the visibility, and positive identification/location of aircraft and watercraft (and/or their crews), thereby ensuring their safety during routine operation or in emergency situations, which are most often characterized by foul weather and poor visibility. Present survival aids are insufficient for these situations when exact time-to-locate is critical to survival. In addition, law enforcement agencies, multinational corporations, and transportation companies could take advantage of this technology for positive tagging/tracking of high value facilities or cargoes.

REFERENCES: Joint Chief of Staff Joint Pub 3-09.2, Joint Tactics, Techniques and Procedures for Ground Radar Beacon Operations, describes employment of surface located radar beacons in conjunction with aircraft and naval surface fire support ships. In addition, to providing specific joint combat employment procedures, the publication delineates radar beacon mission planning and coordination responsibilities and addresses the capabilities and limitations of radar beacon capable aircraft and naval surface fire support ships.

SOCOM 97-007 TITLE: Very Lightweight Body Armor (Plates)

KEY TECHNOLOGY AREA: Clothing, Textile and Food

OBJECTIVE: Certify high-threat body armor plate inserts of advanced materials and processes.

DESCRIPTION: Current body armor consists of three elements, including flexible armor (4-6 sq ft, .45 cal/9mm ball), hard plate inserts (front and back 0.7 sq ft each, up to 5.56x57 A059 ("green tip")/7.62x51 M193 ("black tip")/7.62x39 ("CHICOM pin"), referred to as "NIJ level III+"), and a carrier vest. These plates weigh between 6-10 lb and cost $200-800, each, depending on materials used. A common alloy of titanium (specially heat treated) has demonstrated excess capability to fully defeat these threat rounds at weights less than 3.5 lb and costs in the vicinity of $200 per plate.

PHASE I: Determine the minimum thickness and material properties required to defeat the NIJ Level III+ threat rounds at muzzle velocity, appropriate front-face laminate to defeat spall (traveling parallel to the face of the plate into the chin and arms), and appropriate back-face laminates required to assure a multi-hit capability. It will also analyze the cost-effectiveness of alternative designs compared to existing designs.

PHASE II: Complete formal NIJ certification, documenting required capability prior to commercial or military deployment.

PHASE III DUAL USE APPLICATIONS: Direct replacement by backfit or new sales of all police and military wearable armor. Lightweight cost-effective armor for vehicles, aircraft, boats, and buildings.

SOCOM 97-008 TITLE: Advanced Planar (Digital) Antenna for USSOCOM Aircraft

KEY TECHNOLOGY AREA: Air Vehicles/Space Vehicles and Electronics

OBJECTIVE: Develop an Advanced Planar Antenna (APA) that can be easily installed on airborne platforms. The APA must be capable of being applied to an exterior aircraft surface and perform as well or better than current antennas. This development should, at a minimum result in a multiple use, combat survivable, reconfigurable digital antenna with a frequency range no less than 2 MHz to 1 GHz.

DESCRIPTION: All USSOCOM aircraft have a multitude of surface mounted single and multiple use antennas. These antennas are either conformal or nonconformal. The existing conformal antennas provide reduced signature, but have poor performance ratings. The current nonconformal antennas have increased performance, but increase flat plate drag and radar cross section. Additionally, because of location they are susceptible to ground contact and ground handling damage, and if mounted on the underside of the aircraft, must be removed or folded prior to an air transport on a C-141, C17, or C-5. Both conformal and nonconformal antennas are susceptible to flying debris and a single shot combat kill. Finally, because of limited useful exterior surface space on helicopters and the increased avionics requirements of USSOCOM aircraft there are antenna interference problems caused by placement and proximity.

PHASE I: Investigate materials, adhesives and techniques for application on to the various types of materials available on USSOCOM aircraft. Design and optimize antenna design to utilize present locations, to maximize the use of existing wiring, and minimize installation costs. Determine the weight savings, reduction in flat plate drag, and estimated aircraft performance improvements from these changes. Finally, evaluate reliability and maintainability improvements.

PHASE II: Develop prototype Advanced Planar Antennas for each of the identified avionics systems and test on USSOCOM helicopters.

PHASE III DUAL USE APPLICATIONS: This development would have a significant impact on the commercial communications industry. Applications of the Advanced Planar Antenna could be made to commercial aviation, law enforcement and emergency vehicles (air and ground), communication sites (to replace multiple, tall antenna arrays). However, the most significant potential application would be in the demand for antenna technology to enhance personal wireless communications.

OSD, DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING SMALL BUSINESS INNOVATION RESEARCH PROGRAM

PROGRAM DESCRIPTION

Introduction

The Army, Navy and Air Force hereafter referred to as DoD Components acting on behalf of the Office of Technology Transition in the Office of the Director, Defense Research and Engineering, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms, with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercial the results are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results.

The DoD Program presented in this solicitation strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific, technical and commercial merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not a awarded contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be considered. DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract.

The Fast Track provisions in section 4.0 of this solicitation apply.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase 11 where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase Ill. Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General Information questions pertaining to proposal instructions contained in this solicitation should be directed to:

DOD SBIR/STTR Help Desk
Phone: (800)382-4634 (8am to 8pm E.S.T)
Fax: (800)462-4128
email: SBIRHELP@us.teltech.com

Other questions pertaining to a specific DoD Component should be directed to the point of contact identified in the topic description section of this solicitation. Proposals should be mailed to the address identified for this purpose in the topic description section. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are <u>prohibited</u> for reasons of competitive fairness.

OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING
FY 1997 Topic Descriptions

ARMY, Simulation Training and Instrumentation Command (STRICOM)

Technology Focus Area: The Commercialization of High Level Architecture (HLA) and Data Representation

DoD has mandated that all its simulations will be compliant with the High Level Architecture by the year 2001. HLA represents an architecture for future simulations. It is based on the concept of a federation in which a set of simulations work together in a structural way to support diverse-user needs. The HLA has been designed to support interoperability and reuse of DoD simulations, however as a technical architecture it provides multiple opportunities for both development of commercial products to support HLA federations and for use of HLA to support simulation applications beyond the DoD. Extensive information is available on the world wide web at {//www.dmso.mil/projects/hla/} and from the Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996. A Technical Information Package (TIP) with details on the following topics is available for the Defense Technical Information Center.

The following topics support the commercialization of HLA and are structured to provide both DoD and the Commercial Simulation Consumer with enhanced products. The offerors should discuss, in software development terminology, the simulation application's object oriented structure, to include the use of object model template, run time infrastructure, and data representation with the proposed simulation applications. These simulation applications should be discussed as federate in either an existing "known implementation - from the workshop" or a new implementation of a federation.

DEFINITIONS: The following HLA definitions apply to all of the following HLA topics:

Federate - A member of a HLA Federation. All applications participating in a Federation are called Federates. In reality, this may include Federate Managers, data collectors, live entity surrogates simulations, or passive viewers.

Federation - A named set of interacting federates, a common federation object model, and supporting RTI, that are used as a whole to achieve some specific objective.

Federation Object Model (FOM) - An identification of the essential classes of objects, object attributes, and object interactions that are used as a whole to achieve a more complete description of the federation structure and/or behavior.

Runtime Infrastructure (RTI) - The general purpose distributed operating system software which provides the common interface services during the runtime of an HLA federation.

Synthetic Environment Data Representation and Interchange Specification (SEDRIS) - A format-independent data representation model for interchanging synthetic environment databases, including any combination of (but not limited to): terrain, ocean, atmosphere, 3D icons/models, features, topology, sound, textures, symbols, and special effects.

PRIMARY POINT OF CONTACT:

US Army Simulation, Training and Instrumentation Command (STRICOM)
Attn: AMSTI-ET (Mark McAuliffe)
12350 Research Parkway
Orlando, Florida 32826-3276
email: mcaulifm@stricom.army.mil
phone: 407-384-3929
fax: 407-384-3830

OSD97-001 Title: HLA Federation Implementation Tools

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: To develop new and innovative technological solutions to support the development and implementation of High Level Architecture (HLA) federation. These tools target the planning or design phase prior to any Federation operation/interactions.

DESCRIPTION: The need exists to design and develop infrastructure tools to aid in the implementation and use of the HLA to develop, implement and use HLA federations. These tools are desired to provide developers of simulation systems an implementation method for functionality, high fidelity, interoperability, and compliance at a low cost. These tools should address the establishment of the federation object model and the determination of the ~~a~~ level of interoperation for a group of simulation applications to operate in a federation. DoD has established the process in the HLA Federation Development and Execution Process Model which lays out a general view of this process. However, objective is the development of a commercial applications, an open tool architecture is planned, with published data interchange to allow open use of DoD data resources and equivalent commercial information the use of information from a Modeling and Simulation Resource Repository is optional. The offeror should establish the commercial equivalent of these data requirements or identify that they are not required for commercial applications. These tools help to establish a baseline for federation development and integration.

PHASE I: Explore concepts, methodologies, and design possibilities for tools to support the development of a federation baseline for either a commercial or DoD application.

PHASE II: Develop and demonstrate the approach from Phase I. The product could be used by multiple simulation application manufactures to establish and develop common interactions and information transfer in an HLA federation to accomplish a specific objective (in manufacturing, analysis, simulation or design).

DUAL USE COMMERCIALIZATION: DoD believes that HLA is the technology thrust for interoperability. Commercial applications which desire to interoperate could use the same paradigm. The process of facilitating a federate and federation is labor intensive. The use of sophisticated tool sets which alleviate tasks and enable more efficient implementations for commercial developers are desired. Candidates for dual use include information systems management, manufacturing control, and distributed games.

REFERENCES: Hunt, Dahman, Lutz, and Sheehan "Planning for the Evolution of Automated Tools in HLA"
The world wide web at {//www.dmso.mil/projects/hla/ } and from the Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-002 TITLE: HLA Runtime Analysis and Monitoring Tools

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Provide realistic real-time monitoring for the federation, or any federate, during the federation's operation. These tools support activities during federate operation and can provide feedback in after action review.

DESCRIPTION: This type of analysis and monitoring tool ensures proper/legitimate operation of a federation interacting over a network. This includes but, is not limited to, (two Dimensional Plan View Display, a Stealth viewer including attachment to an operating simulation) a recorder and playback capability, a federation controller, ~~and~~ a network performance monitor and data visualization techniques eg.,. Portions of the stored data may be at different physical sites, therefore, effects of distributed recording must be addressed and supported. There have been solutions to the visualization of the simulated battlefield which partially answer the questions of the operation and health of a distributed network implementation. However, a low cost modular approach is needed for use with DoD's HLA and its commercial equivalent. The offeror should review the current capabilities and evolve a flexible HLA compliant implementation which uses the federation object model, and initialization data of a protofederation or a potential commercial application.

PHASE I: Based on real time simulation requirements, design analysis and oversight tools which provide a low cost modular solution for the real time analysis and oversight of an HLA distributed federation.

PHASE II: Based on either a DoD demonstration or a commercial federation implementation, prototype the analysis and oversight tools.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games.

REFERENCES: Hunt, Dahman, Lutz, and Sheehan "Planning for the Evolution of Automated Tools in HLA"
The world wide web at {//www.dmso.mil/projects/hla/ } and from the Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-003 TITLE: HLA Commercial Applications in Simulation

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Demonstrate that HLA provides a commercially viable real-time simulation approach. (An HLA instantiation)

DESCRIPTION: Based on the constructs of HLA, establish a federation object model for a specific objective, design and integrate a commercial group of federates to perform this specific commercial implementation. The offeror should discuss the federation object model, environmental representation, and either the use of a special purpose run time infrastructure (RTI) or request the Government's RTI. The offeror can propose to use the DoD prototype developments, or can suggest alternative solutions. The use of either a commercial variant or a commercial application will help verify the validity of the HLA, and provide opportunities for novel design. This commercial application of a federation could be a real-time interactive game, a real-time management and oversight of a manufacturing facility or another commercial application.

PHASE I: Based on real-time simulation requirements, design a commercial federation (A named set of interacting common object models, and supporting RTI, that are used as a whole to achieve some specific objective).

PHASE II: Prototype and demonstrate the federation.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games in a virtual environment.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/} and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-004 TITLE: Visual Representation within the HLA

TECHNOLOGY: High Performance Computing and Simulation

OBJECTIVE: Demonstrate realistic dynamic images for a distributed virtual gaming environment operating in an HLA environment.

DESCRIPTION: Using the HLA and Run Time Infrastructure (RTI) constructs and the Synthetic Environment Data Representation Interface Specification (SEDRIS) demonstrate commercial applications for high resolution displays.

PHASE I: Based on real-time simulation requirements design a visual presentation either in a helmet mounted display or on a graphics workstation. Extract a synthetic environment for a small gaming area from an existing SEDRIS data base. Design a small set of typical interactions required between two ground players and two aircraft and implement the interactions using the RTI. Perform an analysis to determine the capability of the HLA infrastructure and the resulting synthetic environment to support a distributed virtual gaming environment.

PHASE II: Prototype the simulation and meet real time frame rates using the synthetic environment developed from SEDRIS, air and ground players. Demonstrate the capability of the synthetic environment representation and the RTI to support dynamic changes to the environment.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games in a virtual environment.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the

Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-005 TITLE: Stimuli (non-visual) Representation within the HLA

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Demonstrate that HLA supports the implementation of different sensory stimuli (other than visual) in the virtual environment. This topic addresses the potential of haptic, audio, olfactory and other stimuli into the virtual reality within the HLA paradigm.

DESCRIPTION: Provide a novel approach which supports sensory stimulation using the HLA constructs and its environmental data. This topic provides the avenue to ensure that alternate sensory data and its representation can be supported within a federated object model, the RTI and its environmental representation.

PHASE I: Identify at least one stimuli, model the stimuli in a federated object model and design an implementation which supports a real time presentation of the stimuli. The Offerors should describe the interaction which support the sensory stimulation in a virtual environment. Describe the external federate activity which causes the need for the activation of a stimuli, and the timing and effect of that stimuli on the participant.

PHASE II: Build and demonstrate a prototype of the sensory stimulation system.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games in a virtual environment.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-006 TITLE: Commercialization of Components C4I Interface to Simulation using HLA

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Many simulations require tactical intelligence information and audio communication. This topic's thrust is to develop commercial applications which use the current C4I HLA constructs.(HLA instantiation)

DESCRIPTION: The need exists to accommodate a wide variety of real-world command, control, communications, computers, and intelligence (C4I) equipment into the synthetic environment. A primary DoD thrust for this effort is the Modular Reconfigurable C4I Interface (MRCI).

PHASE I: Establish a set of C4I simulations and interfaces which have commercial value. Based on this set of applications, establish a scaleable design for this simulation application.

PHASE II: Prototype the design and demonstrate it in either a DoD or commercial Federation.

DUAL USE COMMERCIALIZATION: The ability to inject audio communications and intelligence is applicable to the information technology management, telemedicine applications and distributed game market, which use integrate analogue and digital signals.

REFERENCES: Position Paper 96-15-056 "Detailed Design of the Modular Reconfigurable C4I Interface (MRCI)" by Tom Tiernan, NRaD and Mark Cosby, SAIC
The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-007 TITLE: Data Management/ Analysis Tools

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Rapid reduction and analysis of federate and federation data is required. This analysis spans from an attribute level comparison through the sophisticated analysis on a simulation effect. The ability to parse data including audio and video data in a near real time analysis capability is required.

DESCRIPTION: There are large volumes of data used in federate and federation initialization and operation. The federation performance cannot be efficiently reviewed without automated data management tools. Analyze the effect of an additional passive federate on an exercise. These tools will allow the reconstruction of an entire federation exercise. This topic requires the synthesis of distributed recorded data, and the decomposition of the data into significant activities for replay and analysis.

PHASE I: Design a modular data management process which will support all federation generated data. Identify approaches to increase response times.

PHASE II: Prototype data management system for use on a DoD or commercial federation.

DUAL USE COMMERCIALIZATION: There is a large community who desire rapid access and analysis of data. Techniques should support commercial information technology data management.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.

NAVY, Naval Undersea Warfare Center Division, Newport

Technology Focus Area: Sensors

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Mail all Proposals to: Commercial Acquisition Department
SBIR OSD97-### Atten: Code 5912
NUWC Division, Newport
Simon Pietri Drive
Newport, RI 02841-1708

OSD97-008 TITLE: Underwater Acoustic/Optical Imaging

OBJECTIVE: Develop an underwater acoustic/optical imaging system or innovative sensors

DESCRIPTION: Combining the complementary strengths of acoustic and optical imaging technologies offers the potential to enhance the quality of underwater images required in a variety of military and civilian applications. Such combinations have been demonstrated with, for instance, ultrasonic sonar and laser line scan. This topic requests the development of innovative acoustic/optical technologies to be combined in an affordable imaging system suitable, depending on design, to such applications as hand held devices for divers, systems for unmanned underwater vehicles or stations, larger subsurface or surface craft. Proposals must demonstrate the intention to develop a dual use product and an understanding of what such development entails. The objective of the topic is the development of an innovative imaging system based on innovative acoustic/optical sensors.

PHASE I: Design, develop, fabricate, and demonstrate proof of concept sensors.

PHASE II: Fabricate and evaluate a prototype of the imaging system which combines sensors, developed in Phase I.

DUAL USE COMMERCIALIZATION: The system will have similar civilian and military applications such identifying underwater objects, finding environmental hazards, imaging for underwater construction or structural inspection, conducting research.

OSD97-009 TITLE: High Efficiency, Broadband, Acoustic Transducers/Arrays for Various Underwater Applications

OBJECTIVE: Develop reliable, simple affordable, highly efficient, broadband acoustic transducers/arrays for a variety of underwater applications.

DESCRIPTION: Recent developments in materials suitable for transduction and the design of multi-layer active drivers provide the potential for transducers which can satisfy military and nonmilitary applications with more versatility and more simply, reliably, and affordably than previously possible. Such materials include piezoelectric and electrostrictive ceramics, magnetostrictive alloys, electroactive polymers, and electrostrictive urethanes. This topic contains two subtopics. Offerors may propose under either or both subtopics; however, separate proposals shall be provided for each subtopic. The emphasis is development of transduction mechanisms vice new material development.

Subtopic 1. Multi-purpose Conformal arrays. Under this subtopic, offerors should propose arrays which serve more than one function and which, if used at deep depths, are operable without a pressure compensation system. Applications (depending on frequency): close in imaging, for instance in the near surf; generation of high intensity ultrasound to effect sonochemical reactions or generate cavitation to break up and neutralize oil globules or hazardous biological waste; underwater acoustic communications; passive detection and localization of other platforms or marine mammals; acoustic communications; reduction of radiated vehicle noise and/or vibration for military or nonmilitary vehicles and vessels to increase detection ability and to provide greater passenger comfort. In the high frequency (above 20 kHz) regime, very broadband highly efficient arrays capable of handling very high power densities and suitable for versatile use in shallow water; lightweight, less powerful imaging arrays suitable for diver use. In the lower frequency regime (below 4 kHz): reversible underwater arrays for radially compact conformal mounting on the outer surface of a submersible hull, such as a Unmanned Underwater Vehicle (UUV); capable of wide bandwidth transmit, receive, and beamforming and of functioning as an actively controllable surface for radiated noise reduction below 2 kHz.

Subtopic 2. Low frequency projector for deep depths. Applications: acoustic tomography studies; oceanographic experiments; undersea warfare. Underwater acoustic projector capable of acoustic power output of 500 watts from 50 Hz through 100 Hz with an electroacoustic efficiency greater than 50%. Operable at depths up to 1000 meters without an active compensation system. Must be environmentally suitable to be used as an expendable source.

PHASE I: Design and document design rationale. Fabricate and demonstrate proof of concept element(s).

PHASE II: Modify design as required. Fabricate and demonstrate prototype device.

DUAL-USE COMMERCIALIZATION: See subtopics above. Proposals should demonstrate that offerors have carefully considered the challenges offered by developing technology into dual-use products.

OSD97-010 TITLE: Affordable Underwater Sensing Technology for Autonomous Underwater Vehicles (AUVs)

OBJECTIVE: Develop affordable sensing technology on a scale suitable for integration on AUVs.

DESCRIPTION: Physical, fluorescence and other optical sensing technologies can now be configured for integration onto AUVs for shallow and very shallow water applications. Several sensor technologies are on the threshold of achieving the affordability, low-power, robustness, and miniaturization needed for such applications. For Navy applications, the sensors would be housed on a 7" internal diameter autonomous swimming vehicle or on a 9" x 13.5" x 5" bottom crawler. for undersea warfare and dual use applications.

PHASE I: Develop a preliminary design utilizing affordable physical and optical sensing, vehicle configuration and component integration. Develop proof of concept sensors and conduct preliminary field testing.

PHASE II: Develop final version of the design. Fabricate prototype sensor system, integrate on AUV, and test in both a military and industrial sector application.

DUAL-USE COMMERCIALIZATION: Applications of this technology include: Tactical Oceanography for shallow and very shallow water operations; small object search and detection; environmental monitoring; mapping of sewage plumes, oil spills, hazardous waste and nuclear disaster sites; humanitarian de-mining; waste dump management.

REFERENCES:
[1] "Sensors for Oceanographic Applications of Autonomous Underwater Vehicles", J. W. Bales MIT Sea Grant College Program, E.R. Levine NUWCDIVNPT, 21st Annual Technical Symposium and Exhibition,AUVS-94, May 23-25, 1994, pp 439-446.

[2] "Dual-Use Applications Using a Flotilla of Smart Mobile Sensors", C.N. Duarte NUWCDIVNPT, D.T. Gomez, NUWCDIVNPT, SYMPOSIUM ON AUTONOMOUS VEHICLES IN MINE COUNTER MEASURES, April 4-7, 1995, pp 9-64 - 9-73.

OSD97-011 TITLE: Small, Low Power, Low Cost Beamformer for Portable Imaging Sonar

TECHNOLOGY: High Resolution Beamformer Technology, Sonar Signal Processing Technology.

OBJECTIVE: Develop small, low power, low cost beamformer suitable for use in small high frequency imaging sonars.

DESCRIPTION: Advances in chip technology provide the potential for high resolution two-dimensional beamforming in a package suitable for use, for example, in a diver's hand held imaging array, in a remote imaging sonar on an unmanned undersea vehicle, or with a small surface craft sonar for obstacle avoidance. An innovative approach in beamformer technology is required to meet the size, power and cost objectives. Innovation is also required in system design to reduce high data rates generated at the array to a level compatible with a high performance signal processing which would form the images. The two-dimensional beamformer could be tested on a Government owned high resolution planar sonar array at a Government test facility. Such an array would have on the order of 100 transducer elements and thus allowing an equal number of beams to be formed. The elements would spaced at one-half wavelengths for the center frequency. The center frequency of an array of small enough size can range from 50 kHz to 500 kHz.

PHASE I: Conduct design and analysis for a two-dimensional beamformer and multiplexer suitable for a portable imaging sonar handling approximately 100 channels of transducer data.

PHASE II: Design, optimization, fabrication and test of full system data multiplexer and two-dimensional beamformer. Full 100 channel (approximate channel size) system data multiplexer and two-dimensional beamformer demonstration.

DUAL-USE COMMERCIALIZATION: Current or potential applications include use with sonar arrays for: hand held imaging systems; remotely piloted or autonomous undersea vehicles in support of cable-laying, pipe-following, and salvage; surface or underwater obstacle avoidance; oceanographic research.

REFERENCE: F. Nussbaum, G. Stevens, and J. Kelly, "Sensors for a Forward-Looking High Resolution AUV Sonar," Proceedings of the 1996 IEEE Symposium on Autonomous Underwater Vehicle Technology, 1996, p.141

OSD97-012 TITLE: Piezoelectric Ceramics for High Performance Acoustic Transducers

OBJECTIVE: Develop innovative piezoelectric ceramic formulations or materials processing methods that lead to enhanced performance acoustic transducers.

DESCRIPTION: At the heart of an acoustic transducer lies a material that performs the essential role of electromechanical energy conversion, converting and electrical signal into an interrogating acoustic pulse on transmission, and converting the weak acoustic echoes into an electrical signal on reception. Innovations are sought in the composition of, or processing methods used to make, piezoelectric ceramics for this essential transduction task. The focus of the work lies on the materials processing, but the goal is property improvements that lead to enhanced acoustic transducers for applications ranging from Navy sonar systems to civilian underwater imaging for the detection and clearance of environmental hazards in coastal waters.

PHASE I: Establish feasibility of the proposed composition or processing methods to produce piezoelectric ceramics with properties which will lead to enhanced acoustic transducer performance.

PHASE II: Develop the synthesis or processing regimen to prototype production and demonstrate improved transducer performance in candidate devices.

PHASE III: Manufacture piezoelectric materials with enhanced performance characteristics and supply them to transducer and systems manufacturers.

DUAL USE COMMERCIALIZATION: In addition to their vital role in most Navy sonar transducers, piezoelectric ceramics play a critical role in a wide range of civilian acoustic transducer applications: ultrasonic transducers for medical diagnostic imaging, vibration sensors and actuators in active noise suppression system for air conditioners and the like, and underwater imaging devices for detecting and clearing environmental hazards from coastal waters.

REFERENCES: Proceedings of the 1996 IEEE International Symposium on the Applications of Ferroelectrics
Proceedings of the 1996 IEEE International Ultrasonics Symposium.

OSD97-013 TITLE: Automated Sound Velocity Profiler

OBJECTIVE: Develop innovative, affordable, automated system, including launch and handling, for sampling the sound velocity profile in the water column.

DESCRIPTION: Hand launched expendable devices, such as expendable bathythermographs (XBTs) or sound velocimeters (XSVs) are currently used to sample water column properties. Recent work at the Naval Undersea Warfare Center Division, Newport (NUWCDIVNPT) has focused on possible alternative devices for obtaining the sound velocity profile (SVP). This topic seeks to explore alternative approaches. The SVP is used as input for sonar performance prediction calculations. Launching expendable devices adds to work assignments. In addition, the environmental variability of littoral waters increases the necessity for sampling more frequently and, therefore, increases workload. Developing the technology for an automated or partially automated method for sampling the sound velocity profile without expendable devices would provide increased reliability and maintainability and decrease workload.

PHASE I: Explore alternative technologies for environmental sampling and conduct a tradeoff study to determine the most promising approach. Conduct a design concept study to determine the feasibility of implementing the selected approach. For the Navy, the design concept study must present options which define ship impacts and the integration of device output with a combat system necessary to achieve goals of reduced workload. Provide a detailed design document of the device which implements the recommended technology. Conduct breadboard tests to demonstrate feasibility of approach.

PHASE II: Fabricate a prototype system and conduct performance verification tests.

DUAL-USE COMMERCIALIZATION: This technology is applicable to the next generation Navy surface combatant and as retrofits to current surface combatants, especially in light of the Navy's goal of reduced manning. The technology can benefit commercial activities that require environmental data acquisition such as oil exploration, environmental monitoring, and power plant discharge monitoring.

REFERENCES:

[1] Acoustic - Optic Sound Velocity Profiler, US Patent 5,379,270

[2] Fiber Optic Measurement of the Sound Velocity Profile (Naval Undersea Warfare Center Division, Newport patent in preparation)

[3] Robert J. Urick, Principles of Underwater Sound. New York: McGraw-Hill, 1975, pp. 104-113.

AIR FORCE, Wright Laboratory Topics

Technology Focus Area: Materials and Materials Manufacturing Technology

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OSD97-014 TITLE: Applications of High Temperature Organic Matrix Composites

TECHNOLOGY: Investigate potential high temperature organic resins that can produced organic matrix composite components by resin transfer molding (RTM) at an operating environment of 700°F.

DESCRIPTION: RTM is rapidly maturing as a processing method of choice to produce affordable, high quality composite components for a number of applications. Currently, the RTM resins with the highest temperature capability are bismaleimides. However, new applications require an RTM resin capable of service at higher temperatures than current resins allow. Examples of possible resin which approach an operating environment of 700°F, and also have properties amenable to RTM processing include, but are not limited to, polyimides, and phthalonitriles.

PHASE I: Explore available high temperature resins to determine properties needed for RTM processing. If necessary, modify the resin formulations or develop new resin formulations. Demonstrate high temperature operating properties at 700°F and the ability to RTM the resin.

PHASE II: Scale up the resin to quantities needed to fabricate large, complex parts for military or commercial applications using RTM. Also, demonstrate the ability to make these types of parts using RTM.

DUAL-USE COMMERCIALIZATITON: High temperature composite materials produced by RTM are excellent candidates for turbine engine components for military and commercial aircraft. These materials may also find application as brake parts, and there are numerous potential applications for high quality, high temperature composites throughout the DoD and commercial sectors.

REFERENCES: 1. S.B. Sastri, J.P. Armistead, and T.M. Keller, Proc. 41st Int. SAMPLE Symp., 171-177 (1996)

OSD97-015 TITLE: Solvent-Free, High T_g Polymer Processing Techniques For Aircraft Canopies

TECHNOLOGY: Materials, Processes and Structures

OBJECTIVE: Investigate, design and develop viable processing techniques which retain or improve optical transparency and impact properties for high glass transition polymers.

DESCRIPTION: New high use temperature polymeric materials shall be required for use in future airframes to enable the full performance characteristics of the weapon systems. Some new high temperature transparent thermoplastics have been prepared in recent years which possess glass transition temperatures (T_g's) up to 250-350 degrees C and minimum room temperature tensile mechanical values of 0.45 Msi modulus, 11 Ksi strength and 4.7% elongation to break. New manufacturing technology in non-solvent based processing techniques which retain or improve the inherent optical and mechanical properties at room temperature as well as maintain reasonable processing temperatures is sought. Typical melt consolidation above T_g and pressures of up to 100 Ksi may make for unrealistic fabrication for large commercial scale sheets compared to the state-of-the-art injection molding and extrusion devices. A model forming technique and device design is sought for proof of concept using such high T_g materials.

PHASE I: Phase I effort shall include the familiarization of the offeror with high use temperature (i.e.,

>400°F, long term) thermoplastics in order to identify families of potential candidate transparent aircraft transparency materials. Synthesis of the novel candidate materials to large scale (i.e., tens of pounds) shall be required. The Phase I research shall also enable the offeror to evaluate the existing and improved forming techniques, to design a prototype fabrication device to produce a transparent high T_g disk-shaped specimen nominally 1" dia. X 1/8" thick, to fabricate 5-10 specimens of a designated high use temperature candidate material with the described dimensions, and evaluate thermomechanical (including impact) properties, optical parameters such as luminous transmittance, haze and yellowness index at room temperature and near T_g and accelerated aging techniques such as QUV and rain erosion.

PHASE II : In Phase II of the effort the technical work shall require the acquisition and fabrication of larger and more complex shaped specimens of high use temperature transparent materials based on the technology developed in Phase I. Evaluation of the optical quality of the materials shall continue with examination of formulated resins and the effects of the processing technique or modifications thereof upon QUV, weathering (durability), luminous transmittance, haze and yellowness index. Full thermoanalytical, thermomechanical and rheological characterization shall also be required as modifications to the forming process are completed.

DUAL USE COMMERCIALIZATION POTENTIAL: Dual use potential exists for the successful process that optimizes low operating cost and rapid cycle with high use temperature amorphous or semi-crystalline thermoplastics. Commercial applications would include high impact resistant, high use temperature personal protective goggles and face shields, and lenses for elevated temperature environments, and flame resistant commercial aircraft windows.

REFERENCES: (1) DTIC AD-A267-526 (1993) and DTIC A229-339 (1990). (2) L.K. English, *Materials Engineering* 68 (May 1988). (3) S. Witzler, *Advanced Composites* 55 (March/April 1988). (4) P. M. Hergenrother et al., *Polymer 29 (2)* 358 (1988).

OSD97-016 TITLE: Materials for Rocket Propulsion

OBJECTIVE: Develop advanced rocket propulsion materials and cost effective techniques for their fabrication.

DESCRIPTION: There is a critical need for novel, innovative approaches in the development and processing of materials which can aid the advancement of rocket propulsion technologies. For example, the year 2010 goals of the DoD/NASA Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Initiative cannot be met without new materials and manufacturing processes that increase performance, reduce weight, and decrease hardware and support costs of rocket propulsion systems. Specifically, goals for booster systems include: 1) increasing liquid rocket engine thrust-to-weight by 100%; 2) increasing mass fraction of solid motors by 35%; and 3) decreasing cost and time of manufacturing by 25%. New approaches are requested to develop and characterize:
(a) advanced materials that can meet these goals; and/or (b) innovative, cost effective processing techniques for these materials. Candidate materials include, but are not limited to, polymers, polymer matrix composites, metals and intermetallics, metal matrix composites, ceramics, ceramic matrix composites, carbon-carbon composites, thermal barrier coatings, and functionally graded materials. Research in this Topic is anticipated to provide a maximum of innovative flexibility while yielding promising commercial application/dual use technologies to prospective investigators.

PHASE I: This program will focus on the critical propulsion material and processing issues which, when successfully addressed, will provide proof of concept. Proposals should demonstrate reasonable expectation that proof of principle can be attained within Phase I, and that results will favorably impact future component application of these materials.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where performance is demonstrated on a scale sufficient to permit an assessment of the ultimate application potential to help meet Air Force advanced rocket propulsion needs.

POTENTIAL COMMERCIAL MARKET: Materials for rocket propulsion will transition into the US commercial space launch industry, thus enabling the US industry to more favorably compete with foreign sources for space launch opportunities through reducing the life cycle cost of inserting payloads to space obit. Materials for rocket propulsion technologies also serve the commercial sector by enhancing our ability in remanufacture and maintenance of the US ballistic missile fleet.

REFERENCES:

1. "Materials for Advanced Rocket Propulsion--An Assessment of Materials and Process Development Needs," E.L. Courtright, et.al., Wright Laboratory Technical Report WL-TR-96-4086, Wright-Patterson AFB, OH, December 1996.

2. "The Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program," M. Wierschke, 1995 JANNAF Propulsion Meeting Proceedings, JHU Chemical Propulsion Information Agency, Columbia, MD, 1995.

Technology Focus Area: Materials Manufacturing Technology

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Technical Point of Contact: Diana M. Carlin, WL/MTPN
Phone: (513) 255-7277

OSD97-017 TITLE: Breathable Release Coating Development to Use on Ceramic Tooling

DOD CRITICAL TECHNOLOGY AREA: Manufacturing Science & Technology

OBJECTIVE: Develop or modify a release coating for use with ceramic tooling capable of withstanding cure temperatures in excess of 700°F. This release coating must be capable of providing both release and volatile removal for solvent based composite materials which process at temperatures up to 750°F.

DESCRIPTION: The use of castable ceramic tooling for fabrication of solvent-based composite parts requiring two-sided tooling has significant cost advantages if acceptable release materials are available. Solvent based composite materials systems require manufacturing methods which allow in-situ removal of solvents. For parts which require tooling to one surface only, porous materials may be utilized on the non-tooled surface to allow permeation of the volatiles from the part. In the case of parts which require tooling on both surfaces, the tooling material itself must be sufficiently permeable to allow volatile removal and must be finished with an appropriate release coat or be inherently adhesion resistant to the composite material. For tooling materials which are not inherently adhesion resistant, the release coat must not only provide a mechanism for release of the composite part from the tool, but also a mechanism for permeation of the volatiles from the part and through the tooling material.

PHASE I: Develop or modify a release coating material capable of providing both release and volatile removal for solvent based composite materials which process at temperatures up to 750°F. Evaluate the candidate materials' resistance to thermal shock and its adhesion to castable ceramic tools. Additional test will be conducted to evaluate permeability of the release coating material(s).

PHASE II: Build upon the Phase I work to refine the concept, scale-up, and ready the concept for factory floor operations.

DUAL USE COMMERCIALIZATION POTENTIAL: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical.

REFERENCES: Handbook of Composites, George Lubin, Ed., Van Nostrand Reinhold Company, New York (1982). pp.374, 633-639.

OSD97-018 TITLE: Advanced Fasteners for Low Cost Airframe Assembly and Repair

DOD CRITICAL TECHNOLOGY AREA: Manufacturing Science & Technology

OBJECTIVE: Develop and demonstrate advanced fastener technology that will significantly reduce the cost of airframe assembly. Evaluate the feasibility of using advanced fasteners to relax dimensional tolerance requirements and substantially reduce or eliminate associated tooling cost.

DESCRIPTION: All future DOD weapons systems are being developed with major emphasis on achieving maximum performance at an acceptable cost. The airframe assembly operation represents a major portion of the overall manufacturing cost. Significant potential exists for lowering the cost of assembly by eliminating or reducing the need for drill tooling and pre-assembly fixtures. the development of advanced fasteners that relax hole tolerance requirements could substantially reduce cost associated with the fabrication, certification, and maintenance of high tolerance interchangeable / replaceable drill tooling.

Advanced fasteners are required that allow for loose tolerance holes and provide adequate interface for high load transfer effectively. The new fastener technology should be applicable to both permanent and replaceable fasteners. Tensile strength, shear strength, weight and configuration of the advanced fasteners should satisfy the requirements of advanced fighters such as the F-22 or Joint Strike Fighter (JSF).

PHASE I: Develop advanced fastener concepts for both permanent and replaceable fasteners based on advanced fighter cost and performance requirements. Develop a detail design of an advanced fastener and perform stress and fatigue analysis. Prototype fasteners will be fabricated and screen tested to demonstrate concept feasibility.

PHASE II: Based on Phase I test data, develop detail designs and perform stress and fatigue analysis for the most promising fasteners. Fabricate the advanced fasteners and fastened joint test coupons and test to advanced fighter static and fatigue performance requirements. Perform a life cycle cost analysis for implementation on an advanced fighter.

DUAL USE COMMERCIALIZATION POTENTIAL: This advanced fastener technology could be used to reduce the cost of commercial products such as airliners, business jets, high speed boats, etc. This technology would have wide commercial application and could be used to further reduce the cost of commercial products with mechanically fastened joints.

REFERENCES:

(1) Handbook of Composites, George Lubin, Ed., Van Nostrand Reinhold Company, NY (1982). pp. 602-632.
(2) Composite Airframe Structures, Michael C.Y. Niu, Conmilit Press Ltd., Hong Kong (1992).pp. 290-330.

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
Appendix A (or photocopy) must be signed and included with each proposal submitted.

Appendix B: **Project Summary Form**
Appendix B (or photocopy) must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Appendix D: **Fast Track Application Form**
A new DoD pilot program that provides interim funding and DoD's highest priority for Phase II award to projects that attract third party investors.

Appendix E: **Company Commercialization Report**
A report that identifies each Phase II SBIR and/or STTR project your firm has received, and Phase III sales and/or funding resulting from each project. All Phase I and Phase II proposals must include a Company Commercialization Report.

Reference A: **Proposal Receipt Notification Form**

Reference B: **DTIC Information Request Form**

Reference C: **Directory of Small Business Specialists**

Reference D: **SF 298 Report Documentation Page**

Reference E: **DoD SBIR/STTR Mailing List Form**

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____________________

____

FIRM NAME: ____________________

MAIL ADDRESS: ____________________

____

CITY: ____________________ STATE: ________ ZIP: ________

PROPOSED COST: ____________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a socially and economically disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	☐	☐

____________________ ____________________

____________________ ____________________

▸ Number of employees including all affiliates (average for preceding 12 months): ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
TELEPHONE: ____________________	TELEPHONE: ____________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____________________

____________________ ________ ____________________ ________
SIGNATURE OF PRINCIPAL INVESTIGATOR DATE SIGNATURE OF CORPORATE BUSINESS OFFICIAL DATE

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal. In addition, (4) complete copies of the proposal must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSAL TITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words or short (2-3 word) phrases that describe the Project.

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

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Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

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2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Subcontracts (eg., consultants)
    a. Identify each, with purpose, and dollar rates
    b. Total estimated subcontracts costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION FORM

Failure to fill in all appropriate spaces may cause your application to be disqualified

FAST TRACK PROGRAM QUALIFICATIONS (see Section 4.5 of the solicitation for detailed explanation)
To qualify for the SBIR Fast-Track, a company must submit the following items, within 120 days after the effective start date of its Phase I contract, to the same address the company would send its Phase II proposal (see back):

(1) This application form, completed (please also send a copy to OSD SBIR -- see back);
(2) A commitment letter from an independent third-party investor indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, at the matching rate noted below (under Business Certification);
(3) A concise statement of work for the Interim SBIR effort (if an interim option was not negotiated on the Phase I contract) -- under 4 pages in length -- and a concise cost proposal for the interim effort -- under 1 page in length;
(4) A concise report on the status of the Phase I project (if required by the DoD component that is funding the project) -- under 4 pages in length;

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project (unless a different deadline for submission of fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component).
(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released (see Section 4.5 for explanation)

TOPIC #: ______________ CONTRACT #: ______________________ PHASE I COMPLETION DATE: ____________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ______________________________ STATE: ________ ZIP: __________

BUSINESS CERTIFICATION:

	YES	NO	MATCHING RATE
▸ Do you have 10 or fewer employees and have never received a Phase II SBIR award from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is 25 cents for every SBIR dollar)	☐	☐	25¢:$1 ☐
▸ Have you received 5 or more Phase II SBIR awards from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is $1 for every SBIR dollar)	☐	☐	$1:$1 ☐
If you answered NO to both questions, the minimum Third Party matching rate is 50 cents for every SBIR dollar.			50¢:$1 ☐

DOD SBIR AGENCY: ____________________ THIRDPARTY: ____________________

PROPOSED SBIR INTERIM FUNDING: ____________ 3RD PARTY INTERIM FUNDING: ____________

PROPOSED SBIR PHASE II FUNDING: ____________ 3RD PARTY PHASE II FUNDING: ____________

FIRM CORPORATE OFFICIAL

NAME: ____________________

TITLE: ____________________

TELEPHONE: ____________________

THIRD PARTY CORPORATE OFFICIAL

NAME: ____________________

TITLE: ____________________

TELEPHONE: ____________________

______________________ ________ ______________________ ________
SIGNATURE OF FIRM CORPORATE OFFICIAL DATE SIGNATURE OF THIRD PARTY CORPORATE OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX D

General:

The Fast Track Application Form (Appendix D) should be typed in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

When typing address information use the two alphabet characters used by the Post Office for the state (i.e. type NY not New York).

Submission:

Submit all items to the same address you would send your Phase II proposal. This will be listed in the Phase II proposal instructions sent to you at the start of your Phase I project. (If you do not yet have the Phase II proposal instructions, please contact your DoD contracting officer.)

IMPORTANT: Please also send a copy of this application form, when completed, to OSD SBIR, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items to OSD SBIR.

Request for Copies:

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COMPANY COMMERCIALIZATION REPORT

Failure to fill in all appropriate spaces may cause your proposal to be disqualified

FIRM NAME: ____________________

MAIL ADDRESS: ____________________

____

CITY: ____________________ STATE: __________ ZIP: __________

- How many Phase II SBIR or STTR awards has your firm received from the Federal Government (including DoD)? (The answer "none" will not affect your ability to obtain an SBIR award.) ______
- If your firm has received 5 or more Phase II SBIR and/or STTR awards from the Federal Government and the first award was received prior to Jan. 1, 1991, what percentage of your firm's revenues during your last fiscal year is Federal SBIR and/or STTR funding (Phase I and/or Phase II)? ______
- Identify each Phase II SBIR and/or STTR project your firm has received and, for each project, provide the total revenue to date from resulting sales of new products or non-R&D services to DoD or its prime contractors, other government agencies, and private sector customers. Also provide total non-SBIR, non-STTR funding received from government and private sector sources to further develop the SBIR technology (including R&D, manufacturing, marketing, etc.). Apportion sales revenue and non-SBIR, non-STTR funding among the various Phase II projects without double-counting. (See back for further instruction.)

Agency: __________ Topic Number: __________ Contract Number: __________

Project Title: ____________________

DoD/Primes Sales: __________ Other Gov't Sales: __________ Private Sector Sales: __________

non-SBIR/STTR Gov't Funds: __________ non-SBIR/STTR Private Sector Funds: __________

Agency: __________ Topic Number: __________ Contract Number: __________

Project Title: ____________________

DoD/Primes Sales: __________ Other Gov't Sales: __________ Private Sector Sales: __________

non-SBIR/STTR Gov't Funds: __________ non-SBIR/STTR Private Sector Funds: __________

Agency: __________ Topic Number: __________ Contract Number: __________

Project Title: ____________________

DoD/Primes Sales: __________ Other Gov't Sales: __________ Private Sector Sales: __________

non-SBIR/STTR Gov't Funds: __________ non-SBIR/STTR Private Sector Funds: __________

Agency: __________ Topic Number: __________ Contract Number: __________

Project Title: ____________________

DoD/Primes Sales: __________ Other Gov't Sales: __________ Private Sector Sales: __________

non-SBIR/STTR Gov't Funds: __________ non-SBIR/STTR Private Sector Funds: __________

Agency: __________ Topic Number: __________ Contract Number: __________

Project Title: ____________________

DoD/Primes Sales: __________ Other Gov't Sales: __________ Private Sector Sales: __________

non-SBIR/STTR Gov't Funds: __________ non-SBIR/STTR Private Sector Funds: __________

FIRM CORPORATE OFFICIAL

NAME: ____________________ TELEPHONE: ____________________

TITLE: ____________________ FAX: ____________________

____________________ __________

SIGNATURE OF FIRM CORPORATE OFFICIAL DATE

(Page ____ of ____)

INSTRUCTIONS FOR COMPLETING APPENDIX E

General:

The Company Commercialization Report (Appendix E) shall NOT be counted toward proposal page count limitations.

Appendix E should be the last page(s) of your proposal.

Use as many Appendix E forms as needed to report ALL Phase II projects. (Make black and white copies of this form, if necessary.) If multiple pages are submitted, fill in the "Page___of___" in the lower right corner.

Type in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

Use the Post Office two-letter abbreviation for the state (i.e. type NY not New York).

Definitions:

Sales - sales of products or non-R&D services resulting from the technology associated with this Phase II project. Sales also includes the sale of technology or rights. Specify the sales revenue in dollars (1) to the DoD and/or DoD prime contractors, (2) to other government agencies (federal, state, local and/or foreign), and (3) to the private sector. Include sales made by your firm as well as by other firms that may have acquired the SBIR-developed technology.

non-SBIR/STTR funding - non-SBIR/non-STTR government or private sector funds to further develop the technology (including R&D, manufacturing, marketing, etc.) associated with this Phase II project.

Apportion sales/funding - If two or more Phase II projects contributed to a single products or technology right that has been sold or received non-SBIR, non-STTR funding, divide proportionately the sales or funding among the contributing projects. For example, Phase II projects A and B lead to the sale of a new product "Widget" to the Army for a total of $10 million and to retail software stores for $12 million. Under the heading "DoD/Primes Sales:" put $5 million and under the heading "Private Sector Sales:" put $6 million for both Phase II projects A and B.

non-R&D Services - any services that do not include additional R&D work on the SBIR technology -- for example, engineering services, study and analysis, information services.

Submission:

ALL Phase I and Phase II proposals must include a Company Commercialization Report (Appendix E). Please do not submit supplemental material.

Request for Copies:

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

Proposer: If you wish to be notified that your proposal has been received, please submit this form with a stamped, self-addressed envelope.

TO: ____

____

____

Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 97.2

Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____

Fill in name of organization to which you will send your proposal.

____ ____________

Signature by receiving organization Date

DEFENSE TECHNICAL INFORMATION CENTER

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR TECHNICAL DOCUMENT SERVICES

Small Businesses are encouraged to obtain Technical Information Packages (TIPs), annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC), prepared for each SBIR topic in their technology area. The cited technical reports cover selected DoD-funded work related to the topics you select. Reasonable numbers of technical reports may be obtained at no cost from DTIC during SBIR Solicitations. See Section 7.1 for a more detailed description of DTIC SBIR services.

1. You may fold, stamp and mail this form. Remember, significant mailing delays can occur.

2. Alternatively, you may also telephone, fax or Email requests, or obtain TIPs from the DTIC SBIR Web site.
   Phone: 800-363-7247
   FAX: 703-767-8228
   Email: sbir@dtic.mil
   WWW: http://www.dtic.mil/dtic/sbir

3. Technical reports of interest, in addition to those cited in the TIPs, can be identified using STINET, the online technical reports database, available on the DTIC SBIR Web Site.

4. DTIC provides technical services under the SBIR program year-around. Authorization to provide free documents is in effect during solicitations only.

REQUESTER ______________________________
Name

ORGANIZATION NAME ______________________________

ADDRESS ______________________________
Street

______________________________ PHONE ______________
City State Zip Code Area Code/Number

FAX ______________ EMAIL ______________

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER	TOPIC NUMBER	TOPIC NUMBER	TOPIC NUMBER
1 ________	5 ________	9 ________	13 ________	17 ________
2 ________	6 ________	10 ________	14 ________	18 ________
3 ________	7 ________	11 ________	15 ________	19 ________
4 ________	8 ________	12 ________	16 ________	20 ________

I confirm that the business identified above meets the SBIR qualification criteria in Section 2.2 of the DoD Program Solicitation.

Signature of Requester: ______________________________

=================FOLD HERE================

STAMP

Return Address

ATTN: DTIC SBIR
Defense Technical Information Center
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

=================FOLD HERE================

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMC San Francisco
ATTN: Joan Fosbery
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7042

DCMC San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 100
San Diego, CA 92111-2241
(619) 637-4922

DCMC Seattle
ATTN: Alice Toms
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(206) 889-7317/7318

DCMC Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92172-2700
(714) 836-2913 (ext. 659 or 661)

DCMC Van Nuys
ATTN: Dianne Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 756-4444 (ext. 201)

DCMC St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5476
(800) 325-3419

DCMC Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6170 (ext 231 or 229)

DCMC Chicago
ATTN: Greg Wynne
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMC Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381
(800) 722-8975 (ext 165)

DCMC Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1573
(612) 335-2003

DCMC Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMC Dallas
ATTN: Jerome W. Anderson
1200 Main St., Rm. 640
P.O. Box 50500
Dallas, TX 75202-4399
(214) 670-9205

DCMC San Antonio
ATTN: Thomas J. Bauml
615 E. Houston St.
P.O. Box 1040
San Antonio, TX 78294

DCMD EAST (DCMDE-DU)
ATTN: John T. McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(617) 753-3243
(617) 753-3174 (FAX)
E-Mail: bdu1078@dcrbab.dla.mil

DCMC Atlanta (DCMDE-GADU)
ATTN: Sandra Scanlan
805 Walker Street
Marietta, GA 30060-2789
(770) 590-6197
(770) 590-6551 (FAX)
E-Mail: sscanlan@dcmds.dla.mil

DCMC Lockheed Martin Marietta (LASC) DCMDE-RLA
ATTN: Erma A. Peacock
86 South Cobb Drive, Building B-2
Marietta, GA 30063-0260
(770) 494-2016
(770) 494-7883 (FAX)

DCMC Baltimore (DCMDE-GTDU)
ATTN: Gregory W. Prouty
200 Towsontown Blvd, West
Towson, MD 21204-5299
(410) 339-4809
(410) 339-4990 (FAX)
E-Mail: gprouty@balt8.dcmds.dla.mil

DCMC Birmingham (DCMDE-GLDU)
ATTN: Lola B. Alexander
Burger Phillips Center
1910 3rd Ave, N.
Suite 201
Birmingham, AL 35203-2376
(205) 716-7403
(205) 716-7836 (FAX)
E-Mail: lbalexander@dcmds.dla.mil

DCMC Boston, DCMDE-GFDU
ATTN: Philip R. Varney
495 Summer Street
Boston, MA 02210-2184
(617) 753-3467/4110
(617) 753-4005
E-Mail: pvarney@dcrb.dla.mil

DCMC Clearwater, North Florida DCMDE-GCDU
ATTN: Jim Masone
Gadsen Building, Suite 200
9549 Coger Blvd
St. Petersburg, FL 33702-2455
(813) 579-3015
(813) 579-3107 (FAX)

DCMC Cleveland, DCMDE-GZDU
ATTN: Herman G. Peaks
555 E 88th Street
Cleveland, OH 44199-2064
(216) 522-5446
(216) 522-6029 (FAX)
E-Mail: bgz9205@dcro.dla.mil

DCMC Dayton, DCMDE-GYDU
ATTN: Thomas E. Watkins
Gentile Station
1001 Hamilton Street
Dayton, OH 45444-5300
(513) 296-5150
(513) 296-5631 (FAX)
E-Mail: twatkins@dayton.dcro.dla.mil

DCMC Detroit, DCMDE-GJDU
ATTN: David C. Boyd
Warren, MI 48397-5000
(810) 574-4474
(810) 574-7552 (FAX)
E-Mail: dboyd@detroit.dcro.dla.mil

DCMD Grand Rapids, DCMDE-GMDU
ATTN: George Harrison
Riverview Center Building
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620
(616) 456-2646 (FAX)
E-Mail: gharrison@gg-link.dcrb.dla.mil

DCMC Hartford, DCMDE-GUDU
ATTN: Carl Cromer
130 Darlin Street
East Hartford, CT 06108
(860) 291-7705
(860) 291-7992 (FAX)

DCMC Long Island, DCMDE-GGDU
ATTN: Eileen Kelly
605 Stewart Street
Garden City
Long Island, New York 11530-4761
(516) 228-5722
(516) 228-5938 (FAX)
E-Mail: bvc2251@garden.dcrn.dla.mil

DCMC Indianapolis, DCMDE-GIDU
8899 E 56th Street
Indianapolis, IN 46249-5701
(317) 542-2015
(317) 542-2348 (FAX)

DCMC New York DCMC-GNDU
ATTN: John Castellane
Ft. Wadeswoth
207 New York Avenue
Staten Island, NY 10305-5013
(718) 390-1016
(718) 390-1020 (FAX)
E-Mail: bvn3724@dcrna1.dcrn.dla.mil

DCMC Orlando, DCMDE-GODU
ATTN: Victor Irizarry
3555 Maguire Blvd
Orlando, FL 32803-3726
(407) 228-5113
(407) 228-5312 (FAX)
E-Mail: virizarry@dcmds.dla.mil

DCMC Pittsburgh, DCMDE-GPDU
ATTN: Richard Spanard
1612 Wm Moorehead Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926
(412) 644-5907 (FAX)
E-Mail: qg6640@pitt1.dcmdm.dla.mil

DCMC Springfield, DCMDE-GXDU
ATTN: Sylvia Liggions
Bldg 1, ARDEC
Picatinny, NJ 07806-5000
(201) 724-8204
(201) 724-2496 (FAX)

DCMC Philadelphia, DCMDE-GDDU
ATTN: Julia Graciano
2800 South 20th Street
P.O. Box 7699
Philadelphia, PA 19101
(215) 737-5818
(215) 737-3598/7046
E-Mail: bgd8957@dcasma1.dcmdm.dla.mil

DCMC Reading, DCMDE-GRDU
ATTN: Thomas Knudsen
1125 Berkshire Blvd., Suite 160
Reading, PA 19610-1249
(610) 320-5012
(610) 320-5075 (FAX)
E-Mail: tknudsen@reading.dcmdm.dla.mil

DCMC Stratford, DCMDE-GBDU
ATTN: Otis Wade
550 Main Street
Stratford, CT 06497-7574
(203) 385-4416
(203) 385-4357 (FAX)
E-Mail: owade@dcrb.dla.mil

DCMC Syracuse, DCMDE-GSDU
ATTN: Ralph Vinciguerra
615 Erie Blvd, West
Syracuse, NY 13204
(315) 448-7897
(315) 448-7914 (FAX)
E-Mail: rvinciguerra@syraa1.dcrb.dla.mil

REPORT DOCUMENTATION PAGE

Form Approved
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12b. DISTRIBUTION CODE

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GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to stay within the lines to meet optical scanning requirements.

Block 1. Agency Use Only *(Leave blank).*

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1Jan88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10Jan87 - 30Jun88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	**PR**	- Project
G	- Grant	**TA**	- Task
PE	- Program Element	**WU**	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

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Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD5230.24, "Distribution Statements on Technical Documents."
DOE - See authorities.
NASA - See Handbook NHB 2200.2.
NTIS - Leave blank.

Block 12b. Distribution Code.

DOD - Leave blank.
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NASA - Leave blank.
NTIS - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only).*

Blocks 17 - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

The DoD SBIR Mailing List

The DoD SBIR Program Office maintains a computerized listing of firms that have requested to be sent copies of the DoD SBIR Solicitations on a regular basis. If you would like to be remain or be added to this listing, please mail in this form.

☐ **YES**, Include my name and address on the DoD SBIR Mailing List

☐ **NO**, Remove my name and address from the DoD SBIR Mailing List

NAME: ____

COMPANY: ____

ADDRESS: ____

CITY: ______________________ STATE: __________ ZIP: ________

PHONE: _(_____)______________________________

To send: *Remove this page, fold along the marked lines on the reverse side, seal with tape or staple, and affix postage.*

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Old Address: ____

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STAMP

Return Address

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566

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NATIONAL SBIR/STTR CONFERENCES

R&D OPPORTUNITIES
FOR
TECHNOLOGY INTENSIVE FIRMS

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All Federal SBIR Departments and Agencies

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ORLANDO, FL **APR 2-4, 1997**

For Registration Information, contact:
(360) 683-5742
http://www.zyn.com/sbir/

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