NAVY
PROPOSAL SUBMISSION
INTRODUCTION

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**).** If you have any questions, problems following the submission directions, or inquiries of a general nature, contact one of the above persons. Phase I proposals must be received by **13 January 1999**. All Phase I proposals and subsequent Phase II Appendices A, B, and E must be submitted 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 through R&D topics which have dual-use potential. All Navy SBIR topics fall within the DOD Science and Technology areas and the Navy Science areas, listed in Table 1. Navy topics will be funded from these areas according to a priority it has established to meet its mission goals and responsibilities. Information on the Navy SBIR Program can be found at (**http://www.onr.navy.mil/sbir**). Additional information pertaining to the Department of Navy mission can be obtained by viewing various Navy World Wide Web sites at http://www.navy.mil

UNIQUE NAVY REQUIREMENTS:

1. Navy requires Appendix A, B and E to be submitted electronically through the Navy SBIR/STTR Website. The company must print out the forms directly from the Website, sign the forms and submit them with their proposal.
2. All Phase I award winners must electronically submit Phase I summary report through the website at the end of their Phase I.
3. Phase II award winners must also submit Phase II Summary Reports through this same websitet.
4. The Navy requires that all Phase II proposers submit Appendix A, B & E through the Navy SBIR/STTR Website and mail only the appendices to the Navy SBIR Program Office listed above.
5. The requirements and time frames for Navy Fast Track submission have been modified and are described below.
6. The Navy only accepts proposals with a base effort less than $70,000 with an option less than $30,000.

NEW THIS YEAR:

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR/STTR Website at (**http://www.onr.navy.mil/sbir**). A “Navy Success Story” is any follow-on funds that a firm has received from past Phase II Navy SBIR or STTR awards. To qualify the firm must submit these success stories no later than **13 December 1998,** through the Navy SBIR Website. The success story should then be printed and included as appendices to the proposal. These pages will not be counted towards the 25-page limit.

The success story information will be used in the evaluation of the third criteria “Commercial Potential”, (listed in Section 4.2 of this solicitation) which includes Companies Commercialization Report (Appendix E) and the strategy described to commercialize the technology discussed in the proposal. Commercialization is viewed as any follow-on funds, from the DOD, DOD contractors or the private sector, used to further develop the technology or from sales of a product. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DOD programs and/or weapon systems. The proposing company should make reference to the attached success stories in the “Commercialization Strategy” section of their proposal so the evaluator knows to look for them. If a firm has never received any Navy SBIR Phase II it will not count against them, and they will be evaluated on the other evaluation criteria listed in Section 4.2 Phase I Evaluation Criteria. If you have any questions about this requirement, call John Williams at (703) 696-0342.

PROPOSAL SUBMISSION CHECKLIST:

SUBMIT YOUR PROPOSAL(S) WELL BEFORE THE DEADLINE.

All of the following criteria must be met or your proposal will be REJECTED.

1. You must use the electronic format described in the section Electronic Submission described below. The Navy will not accept any proposals that do not have electronic forms of Appendix A, B, and E. The electronic appendices submitted must match the paper copies submitted via mail/express delivery.

2. An electronic version of Appendix E must be submitted with all proposals. Even if you have no Phase II or Phase III information to report.

3. Your Phase I proposed cost for the base effort can not exceed $70,000. Your Phase I Option proposed cost can not exceed $30,000. The costs for the base and option should be clearly separate and identified on Appendix A, the cost proposal and in the work plan section of the proposal.

4. Your proposal must be received on or before the deadline date. The Navy will not accept late proposals, or incomplete proposals. If you have any questions or problems with submission of your proposal allow yourself time to contact the Navy and get an answer to your question. Submit Appendices early, as computer traffic increases, computer speed slows down. Do not wait until the last minute.

ELECTRONIC SUBMISSION OF APPENDICES:

Submit your SBIR proposal to the Navy using the online submission. This site allows your company to come in any time (prior to the closing of the solicitation) to edit or print out your appendicies. **The Navy WILL NOT accept any form from this book or any electronic download version except those from the Navy SBIR Website as valid proposal submission forms for the Appendix A, B and E.** Proposers must use the following procedures.

A. Go to http://www.onr.navy.mil/sbiros and click on “SBIR Phase I” box, or you can come through the Navy SBIR/STTR Website at http://www.navysbir.brtrc.com, click on “Submission”, then click on “Submit or Edit Phase I Appendix A and B” and follow instructions.

B. Fill out all the information requested. The screen format will look different then the forms in the solicitation. Once you have filled in the data, follow the instructions to electronically save/submit appendices. That is, make sure you click on the Save/Submit button, which will save your appendix to the Navy server. You will still be able to return and edit this text up to solicitation closing, at which time the Navy will close down the site. Your electronically submitted version should match the signed paper appendicies submitted with your proposal.

C. After you click on the Save/Submit button, follow instructions to print out the appendicies and sign them. The printed forms from the website may look different than the forms in book and the signature block may appear on the second page. The Navy requires you to include these forms with the mailed hard copy of your proposal. Do not use any other version of the signed forms.

D. Mail the signed Appendix A/B and E forms along with one original and four copies of your entire proposal (the copies should include four copies of the signed Appendix A, B and E forms) to the Navy SBIR Program Office at the above address.

ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an electronic Phase I Summary Report will now be required at the end of Phase I. The Phase I Summary Report is a summary of Phase I results, includes potential applications and benefits, and should not exceed 750 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: http://www.onr.navy.mil/sbir, click on “Submission”, then click on “Submit a Phase I or II Summary Report”. If your company does not have access to the Internet on your computer consult your local library or local computer service store.

The Navy is initiating this new program to help increase the awareness and implementation of SBIR funded efforts. The goal is to increase the market potential and transition of SBIR projects by increasing the visibility and ease in accessing information about SBIR projects to DOD, government and DOD industry contacts. This should facilitate the transition of these projects into follow-on efforts and bring additional revenue to the SBIR Company.

To do this the Navy is asking companies to provide information on the status and benefits of their technology developments so that this information can be put into a media that others can easily access and review. The Navy plans to redistribute this information to a wide audience using such tools as the Navy Webpage, Accomplishment Book and a new interactive Navy SBIR Website. This will help provide parties with technical challenges or those with the need to implement new technology, with a user-friendly mechanism to access and identify SBIR companies that can provide them with solutions.

This information should be **non-proprietary** yet detailed enough to provide the interested transition partner with enough knowledge to understand the potential use and benefit to their program.

NAVY FAST TRACK DATES AND REQUIREMENTS:

All Fast Track Applications and required information must be sent to the Navy SBIR Program Manager at the address listed above and to the designated Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC) for the contract and the appropriate Point of Contact at the end of this Introduction). The following dates and information are required by the company to qualify for the FAST TRACK program. All of the requirements listed in the Fast Track Section of the front of this solicitation must be met. The information provided below provides specific dates and some additional information that is required by the Navy SBIR Program Office.

Party/Days After Phase I Award	Required Deliverables
SBIR Company / 150 Days	- Fast Track Application and all supporting information. (See instructions in the DOD section of this Solicitation) - Phase II 5 Page Summary Proposal, as required of all Phase I Projects as described in Navy SBIR Website listed above. (It is strongly recommended that if you are contemplating the submittal of a Fast Track Application, you make your intention known to your technical point of contact (TPOC) and the SBIR SYSCOM Program Manager for that respective topic, as listed in this Navy section.)
SBIR Company /181 - 200 Days	- Phase II Proposal - Phase I Final Report
Navy / 201 - 215 Days	- Navy will formally Accept or Reject your Phase II proposal.
SBIR Company /45 Days after Acceptance	- Proof that Funding has been received by SBIR company.

ARE YOU A SUPPORT CONTRACTOR FOR A NAVY ACTIVITY?

Do you have employees occupying space in a Navy activity? Or do you have a support contract to provide services outside of an SBIR Phase I, II or III contract award? If so you must indicate this on the Appendix A form. The Navy is concerned with potential conflict of interest and if you reply yes to either of the above you may be precluded from participation in the Navy's SBIR Program in Phase I and Phase II.

YOUR SUBMISSION TO THE NAVY SBIR PROGRAM:

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. The Phase I option should address the transition into the Phase II effort. The 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 (with the exception of Fast Track Phase II proposals). 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 Webpage or request the instructions from the a Navy SBIR Program officer. 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 Phase 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)(Phase II efforts are for two (2) years no more, no less....Phase II options are for an additional six (6) months...a waiver may be granted only from the NAVY SBIR Program Office); 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 or further R&D if the transition plan is evaluated as being successful. You must also submit your Phase II appendix A, B & E electronically to the Navy SBIR Program Office at the address above. 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 SBIR PROGRAM MANGERS OR POINTS OF CONTACT FOR TOPICS

TOPIC NUMBERS	POINT OF CONTACT/ACTIVITY	PHONE
N99-001 to N99-034	Mr. Douglas Harry (ONR)	703-696-4286
N99-035 to N99-043	Mr. Joe Johnson (MARCOR)	703-784-4801
N99-044 to N99-073	Ms. Carol VanWyk (NAVAIR)	301-342-0215
N99-074 to N99-158	Mr. William Degentesh (NAVSEA)	703-602-3005
N99-159 to N99-160	Mr. Mike Letsky (BUPERS)	703-614-6859
N99-161	Mr. Charles Marino (SSPO) Mr. Ron Vermillion (NSWC/DD/DAHL)	703-607-3444 540-653-8906
N99-162 to N99-163	Mr. Dennis Gaddis (NAVSUP)	717-790-7435
N99-164 to N99-173	Ms. Linda Whittington (SPAWAR)	619-537-0146

NAVY 99.1 TOPICS

OFFICE of NAVAL RESEARCH

N99-001 TITLE: Smart Active Networks

SCIENCE/TECHNOLOGY AREA: Command, Control and Communications

OBJECTIVE: Develop and insert new low-cost approaches to data collection and information management in a network-centric environment.

DESCRIPTION: Active networks enable routing elements to be programmed by packets passing through them; thus, allowing computation, previously possible only at endpoints, to be carried out within the network itself. This enables optimizations and extensions of current protocols as well as the development of fundamentally new protocols. The network itself may serve, moreover, as a smart virtual computational device.

PHASE I: Develop novel approaches for active networks, able to route active packets over low-bandwidth or wireless networks consistently and robustly. Develop low-cost network devices that support active network protocols. Design appropriate tools to support remote administration of network and network devices. Define an application of Naval interest, illustrating information processing capability of the network itself, and including realistic performance estimates.

PHASE II: Develop and validate technologies able to define, initialize, select, analyze, and maintain each supported active device and router, and able to do network registration, identification, authentication, audit, application-specific multicast, information fusion, system interconnection, mobility, recovery, and traffic load balancing. Build a realistic prototype based on the above cited application and analyze its performance, scaleability, and costs.

PHASE III: Prepare products for use by network administrators and instructors for civilian and military use. These products should be robust, extensible, compatible with major commercial standards, and suitable for use in advanced concept demonstrations.

COMMERCIAL POTENTIAL: Network information technology and network administration will benefit from affordable technology, capable of supporting local low-bandwidth network devices, and usable in applications from logistics to networked consumer appliances.

REFERENCES:
1. Cebrowski, Arthur K. and John J. Garstka, "Network-Centric Warfare: Its Origin and Future", Proceedings of the Naval Institute, (Jan 1998). URL: http://www.usni.org/Proceedings/Articles98/PROcebrowski.htm
2. Weiser, Mark, "The Computer for the 21st Century." Scientific American (Sep 1991). Related URL: http://www.ubiq.com/hypertext/weiser/SciAmDraft3.html
3. Tennenhouse, David, et al., "A Survey of Active Network Research" IEEE Communications Magazine, (Jan 1997). URL: http://www.tns.lcs.mit.edu/publications/ieeecomms97.html

KEY WORDS: network-centric; active networks; bandwidth; protocols, push-technology; ubiquitous computing

N99-002 TITLE: Quantum Devices and Circuits: Modeling and Design

SCIENCE/TECHNOLOGY AREA: Electronic Devices

OBJECTIVE: To explore the properties of quantum effect devices and develop new device concepts for use in extremely high speed digital applications and high sensitivity detectors of infrared radiation. To provide physics based models for quantum devices which can be validated by experiment. To develop new algorithms for quantum transport describing time dependent transport which will be incorporated in the device models.

DESCRIPTION: Computer programs for circuit simulation based on quantum effect devices must be developed, in which device parameters can be extracted from the physics models. Small signal and large signal applications must be described and simulated so that software packages enabling engineering design of advanced devices and circuits can be realized. Quantum tunneling devices, such as Resonant Tunneling Diodes (RTDs), have recently developed to the point that they are being considered for high speed digital circuits operating at 100 GHz, far beyond the upper frequency limits of silicon CMOS technology (i.e. 1 GHz). There is a great need for such circuits in Navy applications such as digital radar, digital receivers, and the Navy AMRFS project. High sensitivity IR Focal Plane Arrays with multispectral capability have been proposed for ultra performance sensors and missile tracking. These applications need the advantages of very low operating power and circuit compactness intrinsic to quantum devices. The design and development of quantum devices and circuits requires realistic computer simulation tools based on quantum physics models; this requires further advances in quantum transport theory which can be applied in physics based models of tunneling devices. Time dependent effects must be included in quantum tunneling in order to meet the requirements of many of the applications. Real device models must be considered, including the material properties, the geometry, the contacts, etc. This approach will lead to greatly reduced development time and cost, since the output can be used as design tools, avoiding the empirical approaches currently used. A versatile simulation tool can be expected to lead to innovative new devices and applications not currently considered. The physics modeling of the devices will provide real parameters for inclusion in circuit simulations. These simulation will provide accurate, fast, and easy-to-use programs which can be implemented by design engineers. These programs are essential for evaluating many requirements of the applications, such as overall circuit speed, power dissipation, and evaluation of novel circuit architectures. An important requirement is the development of a user friendly and flexible simulation program for use on various computer platforms.

PHASE I: Develop quantum device simulation methods and expand on the theory of quantum transport, including time dependent processes, for inclusion in the physics models. Select appropriate circuit models for simulation and evaluation for the extremely high speed digital applications and for the detection application.

PHASE II: Physics based tunneling models will be further developed to include: 2D and 3D geometries, bandstructure of the multiple layer heterostructures, the adaption to any material implementation and full device configurations, including any contacts. Device parameters will be extracted for insertion into the circuit simulation program. Digital and analog circuit layouts will be designed and simulated for optimum high speed performance. This effort will require development of time dependent solutions to device physics and circuit response, including small and large signal response. Software interface will allow for user control of materials parameters, quantum device geometries, and circuit layouts.

PHASE III: The software product will be sold and/or made available to DoD laboratory and to industrial laboratories developing high frequency circuits under Navy sponsorship. These laboratories include NRL, HRL Labs, and Raytheon T I Systems. For detectors, NRL and JPL. As appropriate, these laboratories will provide technical data to be used in evaluating the software product before delivery or sale. Other government users include NASA, Lincoln Labs, and the Army Research Lab.

COMMERCIAL POTENTIAL: This product will be used by commercial interests to develop digital technology for satellite communications, digital cellular telephones, and for analog technology in covert communications, space communications, and for collision avoidance radar. Infrared detectors will find applications in surveillance. Ultra-low dissipation power and small size is essential to all applications.

REFERENCES:
1. Sun, J.P.et.al., "Resonant Tunneling diodes: Models and Properties," Proceedings of the IEEE, April 1988, pp. 641-663.
2. Mazumdar, P., et. al., "Digital Circuit Applications of Resonant Tunneling Devices," Proceedings of the IEEE, April 1998, pp. 664-688.

KEY WORDS: Terahertz; circuits; quantum; devices; sensors; digital

N99-003 TITLE: Integration of High Density Magnetic Memory into Silicon Electronics

SCIENCE/TECHNOLOGY AREA: Electron Devices

OBJECTIVE: To develop the designs and fabrication technologies for integrating Magnetic Random Access Memory, an advanced nonvolatile memory development at the Naval Research Laboratory, into silicon electronics for wide areas of application. The silicon electronics package will provide necessary power and the read and write wiring to the magnetic element array and will be compatible with commercial VLSI chip manufacturing.

DESCRIPTION: The ONR 6.2 Electronics program has developed an advanced, high density memory technology which utilizes arrays of magnetic metal multilayer elements to store digital information. The storage mechanism is based on the Giant Magneto-Resistive effect (GMR) recently discovered. The NRL development has a unique design which leads to an exceptional performance level, which continues to improve as element dimensions shrink below 1000 nanometers. This will permit storage densities far beyond those projected for silicon memory (DRAM) produced commercially, as well as other GMR memory concepts. Memory chips with capacity in excess of 100 Gigabits are projected. These magnetic elements are non-volatile, that is they retain their memory state even when power is removed. Power is used only in the read and write operations, and thus, power requirements in computation and communication applications will be reduced. In order to implement these memory elements into a VLSI compatible technology, where silicon circuits provide read/write currents to the memory elements, the power supply, and amplifiers for transmitting signals to Central Processing Units, circuits must be designed which can match these functions to the memory arrays. These designs must permit the fabrication of the memory chips as a “back end” process, where the magnetic arrays are integrated at the end of the semiconductor processing and packaging.

PHASE I: The contractor will provide an analysis of the crucial issues in the silicon circuit design, including the trade-offs between density and speed, and the manufacturing constraints imposed by lithographic technologies. This analysis will be used to prepare a preliminary architecture and circuit design.

PHASE II: The contractor shall develop a detailed working circuit layout and will design the mask sets and instruction codes for the fabrication of a working silicon chip. These chips will be fabricated and tested. Finally, the contractor will integrate the magnetic memory arrays onto the functional silicon devices and demonstrate small functioning 1 kilobit arrays which represent memory densities of 10 Megabit per sq. in.

PHASE III: Functional MRAM arrays, scaled to appropriate memory capacity, will be designed and fabricated for insertion into several DoD applications requiring robust, non-volatile, low power memory. These applications include: NAVAIR MAST program; tactical missiles, A9-X, AMRAM and JASSAM which require memory storage to enable programming; upgrades to mission computers in AV-8, F-14 and F-18. Other versions will be replacements for semiconductor memory in portable applications such as computers and cellular communication.

COMMERCIAL POTENTIAL: This novel memory technology will provide low-power, nonvolatile memory at the speed and density of current DRAM and SRAM at lower production cost. Being nonvolatile, it could be a replacement for all memory chips and because of high density potential, could replace mechanically driven hard disk drive storage units.

REFERENCES:

1. Daughton, J. M., “Magnetic Tunneling Applied to Memory”,Journal of Applied Physics, 81, 3758 (1997)
2. Granley, G. B. and Hurst, A. T., Proceedings of the 6th IEEE International Nonvolatile Memory Technology Conference, 138 (Albuquerque, NM) (1996) Pub. 96 TH 8200

KEY WORDS: Memory; Nonvolatile; Giant-Magnetoresistance; Magnetism; Chip; Random Access Memory

N99-004 TITLE: Alternative Lossy Dielectrics for High Power Vacuum Electron Devices

SCIENCE/TECHNOLOGY AREA: Electron Devices

OBJECTIVE: To develop vacuum compatible, electrically lossy, high thermal conductivity alternatives to existing BeO-SiC composites currently used high power vacuum electron devices.

DESCRIPTION: As future DoD radar, communications, and ECM needs push for operation at higher average powers, bandwidths, and frequencies, high-performance vacuum electron devices are running into the limitations of currently available vacuum-compatible materials to accommodate high thermal loading, tailored electromagnetic losses, and high dielectric strength. In addition, there is a developing crisis in the domestic availability of certain (toxic) materials, such as BeO-SiC composites, critical to the manufacture of high power vacuum electron devices. This project seeks to develop alternatives BeO-SiC composite materials.

PHASE I: Identify promising candidate materials that can potentially meet the vacuum, thermal, and electromagnetic requirements currently served by BeO-SiC. In addition, identify promising materials processing techniques to create such high thermal conductivity materials with tailored electromagnetic properties consistent with operation in high power vacuum electron devices.

PHASE II: Fabricate candidate materials using the techniques and processes identified in PHASE I. Evaluate the thermal, mechanical, and electromagnetic properties of these materials, and demonstrate their effectiveness in realistic high power rf environments. Demonstrate that promising materials can be integrated into realistic vacuum electron device fabrication processes. Fabricate and demonstrate a working device, such as a high power klystron or traveling-wave tube, utilizing the new material(s).

PHASE III: The successful development of a new material or materials, and the appropriate materials processing techniques will be transitioned to the NRL Vacuum Electronics Branch and disseminated, through them, to the U.S. vacuum electron device industry.

COMMERCIAL POTENTIAL: Almost every medium-to-high vacuum electron device in the DoD inventory uses BeO, either in its pure form as a vacuum window or insulator, or as a composite (typically with SiC), functioning as a lossy dielectric used to suppress unwanted electromagnetic oscillations (TWT circuit severs, klystron-cavity loss buttons, support structures, etc.). In the past year, economic pressures and increasingly stringent federal and local regulations have reduced the number of U.S. suppliers of BeO-SiC to one, which has increased materials costs and threatens the U.S. supply base. The lack of an acceptable substitute for BeO-SiC has a potentially negative impact on all medium-to-high power military and commercial systems using vacuum electron devices. The development of a replacement material for BeO-SiC has a significant impact on these important systems.

REFERENCES: "Industrial Assessment of the Microwave Power Tube Industry," DoD report, April 1997.

KEY WORDS: lossy dielectrics, BeO-SiC, TWT, klystron.

N99-005 TITLE: Single-Chip Silicon-on-Insulator Global Positioning System

SCIENCE/TECHNOLOGY AREA: Electronics

OBJECTIVE: To develop a low-power, low-cost Global Positioning System (GPS) by designing and fabricating a GPS integrated circuit (IC), including both radio frequency (RF) and digital functions, on a single chip of silicon-on-insulator (SOI) material.

DESCRIPTION: A single-chip GPS would combine high-frequency RF analog processing circuits with digital signal processing circuits for geolocation output. This cannot be achieved using conventional CMOS technology on silicon because the conductive silicon substrate does not allow adequate high-frequency isolation to integrate the RF and digital circuits. By exploiting the insulating substrate of thin film silicon-on-insulator materials for high-frequency RF isolation, integration of both RF analog circuits and digital processing circuits on a single-chip IC should be enabled. To maximize high-frequency RF isolation properties the preferred SOI substrate would be silicon-on-sapphire. To insure dual-use capabilities, it will be necessary to demonstrate design feasibility for single-chip GPS IC's capable of operating in both the military and civilian frequency bands.

PHASE I: Design and analysis of GPS architectures will be performed to demonstrate concept feasibility. This will include specification of optimized designs, manufacturing processes and materials.

PHASE II: Single-chip GPS fabrication, test and evaluation will be performed. Working prototype single-chip GPS IC's based on SOI materials will be fabricated and demonstrated for both military and civilian frequency bands. A transition plan for developing a commercial manufacturing capability will be developed.

PHASE III: A manufacturing capability will be established to fabricate single-chip GPS products for military and civilian markets.

COMMERCIAL POTENTIAL: GPS products are already in widespread use for military and civilian applications. The primary improvement expected from the program will be to produce extremely low-power GPS products which can operate for extended periods on battery power. The secondary expected improvement is that a single-chip IC system combining RF and digital circuitry should be low-cost in comparison to present technology, even after allowing for the expense of using SOI technology. GPS products with these improvements would rapidly dominate future military and civilian markets worth billions of dollars.

REFERENCES:
1. R. Johnson, P. R. de la Houssaye, C. E. Chang, P. F. Chen, M. E. Wood, P. Asbeck, I. Lagnado, "Advanced Silicon-on-Sapphire Technology: Microwave Circuit Applications," IEEE Trans. Electron Dev., May 1998.
2. R. A. Johnson, "Silicon-on-Sapphire Technology for Microwave Circuit Applications," dissertation submitted in partial fulfillment of requirements for the degree of Doctor of Philosophy in Electrical Engineering, University of California, San Diego, May 1997.

KEY WORDS: Silicon-on-Insulator; Silicon-on-Sapphire, Global Positioning System; RF integrated circuits; analog and digital functions on a single chip; wireless communications.

N99-006 TITLE: Improved Efficiency of Multicolor Light Emitting Devices Based on Short-Wavelength LEDs with Down-Converting Phosphors or Polymers

SCIENCE/TECHNOLOGY AREA: Electron Devices

OBJECTIVE: Develop novel approaches to improve the efficiency of multi-color LEDs for lighting or display applications.

DESCRIPTION: The ability to produce visible radiation in a controlled manner is the basis for almost all indoor and outdoor lighting as well as the production of all monochrome and color displays. A wide variety of technologies are used to produce visible light, including those based on incandescence (light bulbs), fluorescence (fluorescent lights) and electroluminescence (light emitting diodes or LEDs). The selection of these various technologies depend on the color, intensity, geometry and costs associated with the particular application. Of particular importance is the ability to produce visible radiation at low cost. Until recently, LEDs have been used primarily for low intensity monochromatic lighting applications such as indicator lights or alphanumeric displays. While LEDs are available over the entire color spectrum, the semiconductor material from which it is made fixes the specific color of an LED. The first LEDs emitted in the infrared and red, and as materials research advanced, other colors became available, with blue LEDs being a relatively recent addition to the range of colors available from LEDs.

Advances in materials research and device fabrication have increased the intensity of red, green and blue LEDs dramatically, so that the light intensity emitted at a particular wavelength can rival that of light bulbs with color filters. This is evident from the use of high brightness red LEDs in automotive tail light applications. The recently developed (InAlGa)N LEDs emitting in the blue and green are of much higher efficiency than even the high brightness red LEDs based on the (AlGa)As materials system [1]. By combining LEDs of the three primary colors, bright, full color displays can be fabricated. However, such displays require assembling large collections of discrete LEDs, since the different colors required are made from different semiconductor compounds.

Another approach to the use of LEDs for the production of visible radiation is to use blue or ultraviolet(UV) emission from (InAlGa)N blue LEDs to excite phosphors [2]. Upon absorption of UV light, the phosphor converts the energy to visible radiation of a color, including white light, depending on the type of phosphor used. Polymeric resins and dye-impregnated plastics can also be used wavelength down-conversion. A wide range of high efficiency phosphors are commercially available, having been used for fluorescent lighting and television screens for many decades. The coupling of a high brightness LEDs and a phosphor has been used to create new, efficient and compact lighting and this technology could be extended to color display systems.

Prototype 'white-light' LEDs are currently available however these devices have a lower efficiency (5.0-7.5 Watts/Lumen) than incandescent lighting (15 Watts/Lumen) and much lower than the theoretical maximum (150 Watts/Lumen)at this time. Improvements need to be made to the external quantum efficiency (QE)of the LED and to the coupling to the phosphor to minimize the strong waveguiding due to the high refractive index of the active region of the LED. The strong waveguiding may limit pixel size in displays if the LED emission cannot be efficiently coupled. In addition, the current approach available in the market only appears 'white' to the eye (it is a mixture of blue (LED) and yellow (phosphor) emission) so the color-rendering index (CRI) needs to be improved. Issues associated with the long-term stability of the phosphor and binders to the exposure of UV radiation over an extended period of time also need to be addressed.

PHASE I: In PHASE 1 schemes to improve the QE of the UV/blue pump source, the coupling efficiency of the phosphor or polymer and the CRI should be explored and demonstrated.

PHASE II: Further development, optimization and packaging of devices will be completed. Scaling and manufacturing issues such as emission over large areas, addressable arrays, etc..

PHASE III: DUAL USE APPLICATIONS: Current military display systems are usually monochrome but require large area multicolor capability for realtime battlefield applications. Single-element indicator lights and monochrome- and multi-color displays represent a market much larger than that of diode lasers in particular if applied to domestic lighting.

COMMERCIAL POTENTIAL: Lighting , and automotive, laptop display industry

REFERENCES:

1. Nakamura et al., Appl. Phys. Lett. 67 (1995), 1868.
2. Sato, N. Takahashi, and S. Sato, Jpn. J. Appl. Phys 35 (1996), L838.

KEY WORDS: LEDs, Display. Polymers, Phosphors

N99-007 TITLE: <u>Improved Performance 10 Kelvin Refrigerator for Electronic Applications</u>

SCIENCE?TECHNOLOGY AREA: Electronics

OBJECTIVE: Design, fabricate and validate the concept of an affordable, compact, lightweight, energy-efficient closed cycle refrigerator capable of providing 100 to 200 milliwatts of cooling capacity at 10 Kelvin for use with <u>terrestrially-deployed</u> superconducting digital circuits and subsystems, Josephson voltage standards, and long wavelength infrared imaging cameras. Units suitable for a spatially distributed array of circuits are also desired.

DESCRIPTION: Cryogenic cooling enables long wave length infrared detectors and complex superconducting circuits. Todays choices include satellite units having the desired performance but costing ~ $1M and overly large units designed for cooling superconducting MRI magnets or absorption pumps that are too heavy and too energy-inefficient to be deployed with electronic devices and circuits. This program seeks to produce an affordable unit optimized for cooling small electronic systems to temperatures near 10 K in a configuration which is small, lightweight and very energy efficient. The performance goals are as follows: Cooling Capacity: 200 (100) milliwatts goal (acceptable) ; Operating Temperature: 9 K.(10K) - goal (acceptable);

Electrical Input Power: 150 (300) watts - goal (acceptable) ; Weight: 10 (30) kilograms - goal (acceptable). Other goals are Cost (in quantity production) ~ $ 10,000; Operating Lifetime: greater than 40,000 hours; turn-key operation; minimal EMI and vibration. Both integral and split configuration, single and double stage designs are acceptable. Choice of the compressor and low temperature regenerators will be important to achieving the cost and reliability goals. The focus of this SBIR is for terrestrial applications: those organizations interested in the development of similar equipment for space deployment are referred to Air Force SBIR AF-99-061

PHASE I: Determine which thermodynamic cooling technologies (Stirling with flexure bearings, free piston Starling, pulse tube, absorption, Brayton, etc.) are capable of achieving the desired thermal, electrical and mechanical specification. Select one or two as the most promising. Define and model performance determinants of a candidate system which could satisfy the goal specifications.

PHASE II: Design, fabricate and evaluate the performance of the selected refrigeration system. Verify that the performance approximates the goals and exceeds the specified acceptable levels of thermal, electrical, and mechanical characteristics of the system. If not, define what modifications must be made to approach the goal values.

PHASE III: Optimize the refrigerator design for integration into a cryogenic system with a niobium nitride Josephson voltage standard, a niobium nitride very high frequency analog to digital converter in a radar or multi-function rf system, or with a cooled VLWIR imaging detector array. This should be done in close collaboration with a commercial vendor of these chips.

COMMERCIAL POTENTIAL: These refrigerators will expedite the use of high speed superconducting digital logic including analog-to-digital converters and digital SQUIDs in laboratory instrumentation, the wide-spread use of very precise Josephson voltage standards for metrological applications, and can improve the resolution and energy sensitivity of infra-red (IR) imaging sensors. Their possible use as oil-free, cryogenic vacuum pumps for small volume systems should also be explored.

REFERENCES: AL.D. Crawford, et al, An Overview of the Air Force Philips Lab Cryocooler Program, p. 3-10 of Cryocoolers 9, ed. R.G. Ross, Jr., Plenum (NYC, 1998).

KEY WORDS: cryogenic refrigerators, cryocoolers, 10 Kelvin, digital superconductivity, VLWIR infrared sensor, analog-to-digital converters

N99-008 TITLE: Wide Bandgap Semiconductor IMPATT Diodes

SCIENCE/TECHNOLOGY AREA: Electron Devices

OBJECTIVE: This work seeks to exploit recent advances in wide bandgap semiconductor (WBS) materials to develop high power, high efficiency Impact Avalanche Transit Time (IMPATT) diode oscillators for operation at 35 GHz and above.

DESCRIPTION: As a result of their high breakdown field (~ 3 MV/cm) and high carrier saturation velocity (~$2.5x10^7$ cm/s), the WBS (namely SiC and GaN) are ideal candidate materials for the realization of high power, high efficiency IMPATT diodes. SiC has the added advantage of a high thermal conductivity (4.9 W/cm K) while GaN has the benefit of heterostructures with AlGaN to tailor the band structure. These properties imply that SiC or GaN based IMPATTs should deliver 100 times the output power of GaAs-based devices since $P_{out}\%v_s^2E_c^2$.

While SiC IMPATTs were studied previously, high frequency oscillators were not demonstrated due to insufficient material and process capabilities at the time (1). With recent advances in the epitaxy and process technology of both SiC and GaN it should now be feasible to produce high power (20 W at 35 GHz) two-terminal oscillators in SiC or GaN (2-4).

PHASE I: The contractor shall develop the process technology, device design, and device model for a high power, high efficiency IMPATT diodes operating at 35 GHz based on SiC or GaN. At a minimum, a reliable, low specific contact resistance (<$5x10^{-6}$ -cm^2) p-type contact shall be demonstrated to p^+-material. Alternatively, a low leakage Schottky contact approach may be proposed. In addition, p^+/n diodes with low reverse leakage and abrupt reverse avalanche breakdown at > 10^6 V/cm shall be demonstrated. Detailed device simulations shall be performed to determine the optimum device structure.

PHASE II: The contractor shall continue to optimize power and efficiency in order to demonstrate a packaged SiC or GaN-based IMPATT operating at 35 GHz with 20 W of CW or long pulse (> 20-30% duty cycle, >30 microsec pulse) output power. The DC to rf conversion efficiency shall be greater than 15%. It is desirable that the proposed effort be coupled to Naval Air Warfare Center (NAWC) Weapons Division work on IMPATT diodes (presently GaAs and InP-based) for missile seekers (http://www.mugu.navy.mil).

PHASE III: The contractor should be able to supply high power, high efficiency IMPATT diodes for developmental missile seekers operating at 35 GHz and above. Power levels of >50 W and DC to rf conversion efficiencies of >20% shall be obtained. Teaming with NAWC in PHASE III would be desirable.

COMMERCIAL POTENTIAL: This work is expected to engender more powerful microwave and mm-wave sources for advanced radar and collision avoidance systems.

REFERENCES:
1. G. W. Eldridge, et al., AHigh Power SiC IMPATT Diode Development, 2nd Annual AIAA SDIO Interceptor Technology Conference, June 6-9, 1993, Albuquerque, NM.
2. I. Mehdi, G. I. Hadda, and R. K. Mains, AMicrowave and millimeter-wave power generation in silicon carbide avalanche devices, J. Appl. Phys. 64, 1533 (1988).
3. K. V. Vasilevski, ACalculation of the dynamic characteristics of a silicon carbide IMPATT diode, Sov. Phys. Semicond. 26, 994 91992).
4. S. N. Mohammad, A. A. Salvador, and H. Morkoc, AEmerging gallium nitride based devices, Proc. IEEE, 83, 1306 (1995).

KEY WORDS: microwave: IMPATT, wide bandgap, silicon carbide, gallium nitride

N99-009 TITLE: High Data Rate Code Division Multiple Access Satellite Network Modem

SCIENCE/TECHNOLOGY AREA: Command, Control and Communications

OBJECTIVE: Develop a code division multiple access (CDMA) modulator and demodulator that will support high data rate (HDR) (T1 >) and medium data rate (MDR) (128Kbps -T1) multimedia network data traffic simultaneously from multiple very small aperture terminal (VSAT) commercial satellite users. This program will leverage technology from existing ONR R&D programs, developing hardware to support the implementation of HDR VSAT SATCOM networks to support naval and Marine forces.

DESCRIPTION: Existing HDR satellite communications (SATCOM) work has demonstrated the ability to achieve T1 class speeds over commercial Ku band satellites using 60cm VSATs and direct sequence spread spectrum (DSSS) technology [1,2]. CDMA SATCOM modem technology is desired to support multiple access and improve system efficiency. HDR CDMA SATCOM modem technology will need the ability to: 1) incorporate adaptive bandwidth efficient modulation types, 2) dynamically implement power control schemes, 3) support adaptive forward error correction (FEC), 4) dynamically adjust data rate and code rate to achieve variable processing gains, 5) be flexible in CDMA code selection, 6) operate over commercial satellite transponders, and 7) operate at commercially accepted intermediate frequencies (e.g., 70MHz and 140MHz). Current DSSS modems lack much of the flexibility necessary to efficiently implement a satellite based VSAT network and current CDMA SATCOM modems operate at unacceptably low data rates to support many multimedia networked applications.
NRL has a CDMA VSAT SATCOM network testbed that can be made available to the contractor, on a not-to-interfere basis, should it be needed to support this development.

PHASE I: Develop or modify a CDMA modulator / demodulator pair with the capabilities listed above. The developer will have the responsibility for identifying appropriate hardware interfaces to support connectivity to baseband devices (i.e. network switches, routers, …) and radio frequency hardware (i.e. up/down converters). The prototype should be flexible enough to support commercially accepted interfaces and interfaces currently in use by the Navy.

PHASE II: Integrate modulators and demodulators into a VSAT SATCOM network supporting multiple nodes in a full mesh and/or star topology. The nodes shall each support flexibility, as previously defined, to address various RF paths and impediments to the RF path by dynamically adjusting power, FEC, data rate, and code rate in an attempt to maintain connectivity at acceptable BER for given network offered load.

PHASE III: Provide a turnkey HDR CDMA VSAT modulator/demodulator system for field testing on Navy platforms.

COMMERCIAL POTENTIAL: The commercial market for VSAT SATCOM networks is large and growing. Many of CDMA's desirable features from the military perspective (reduced antenna aperture, increased satellite transponder efficiency, reduced requirement for network level timing, ability to capture collided signals) have direct applicability in commercial VSAT networks.

REFERENCES:
[1] http://w3.nrl.navy.mil/projects/HDRSATCOM
[2] Rupar, Michael (et. al.), "Demonstration of High Data Rate and Medium Data Rate VSAT Communications using the Global Broadcast Transponder.", NRL/MR/5550—97-7921, March, '97.

KEY WORDS: SATCOM, NETWORKING, CDMA, VSAT,

N99-010 TITLE: Four dimensional (4-D) Atmospheric and Oceanographic Instrumentation

SCIENCE/TECHNOLOGY AREA: Ocean Science

OBJECTIVE: Develop low-weight, low-power, and low-volume instruments/sensors/techniques to autonomously measure atmospheric and/or oceanographic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain meteorological and oceanographic (METOC) variables (e.g., physical, chemical, optical, acoustic, geophysical or biological) in 3-D space and time. The emphasis should be placed on (1) novel approaches and concepts for measuring a particular parameter coherently in 4-D, (2) observations which can be conducted as autonomously as possible (i.e. for independent operation on Remotely Piloted Aircraft (RPA), Autonomous Underwater Vehicles (AUV's), buoys or with expendable instruments), (3) providing a significant reduction in instrument weight and volume without reducing fidelity or resolution as compared to current state-of-the-art devices, and (4) developing the next generation of low cost, potentially expendable instrumentation usable in both navy operational scenarios as well as in S & T environmental data collection. Examples of some of the types of instruments solicited include: bathythermographs, *in situ* ocean wave directional spectral instruments, and the next generation of low cost METOC expendable instrumentation. The term Expendable Instrumentation includes both one time usage as well as long time *in situ* usage, and the sensors should be affordable if expendability is required but reusable if not. Included are instrumentation development efforts that would result in significant improvements and costs savings for existing expendable instrumentation, or would develop new expendable capabilities for measurements currently obtainable by other means (such as aerosol properties, visibility, IR extinction, etc.). All platform deployment scenarios (shipboard, submarine, and aircraft) are included. Priority is given to devices that can lead to substantial improvements in anti-submarine warfare (ASW), mine warfare (MIW), ship self-defense, airstrike targeting and special operations, through improved battle space environmental knowledge.

PHASE I: Provide both an exact description of the parameter to be measured including accuracy and sensitivity along with the instrument design concept for achieving the measurement.

PHASE II: Produce a viable prototype system and demonstrate its ability to support field measurements from an operating autonomous research platform.

PHASE III: Transition the technology to scientific use in the atmospheric, oceanographic or environmental monitoring research communities, and operational DOD systems.

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

KEYWORDS: meteorology; oceanography; instruments; miniaturize; automation; expendable

N99-011 TITLE: <u>Directional Underwater Acoustic Communications Transducer</u>

SCIENCE/TECHNOLOGY AREA: / Command, Control and Communications

OBJECTIVE: Develop a directional underwater transducer for transmitting and/or receiving wideband acoustic communication signals at modem terminals located on, or moored to, the seafloor. The transducer beam should be steerable in all azimuths, either electrically or mechanically, possibly by means of embedded microprocessors. The transducer can be in the form of a refractive lens, reflective dish, antenna, array, parametric sonar, DIFAR, or any other configuration that is affordable, packagable, deployable, and reliable.

DESCRIPTION: The U.S. Navy is advancing deployable, autonomous, distributed systems for surveillance and other undersea applications. The nodes of these systems include low-cost acoustic modems providing wireless links to adjacent nodes. Present transducers are simple vertical line arrays exhibiting omnidirectional response in azimuth and reduced response at high elevation angles. Azimuthal transmit directionality would enhance overall network performance by reducing total transmit power, reducing interceptability, and improving multiple-access network performance. Azimuthal receive directionality would increase signal-to-noise ratios.

PHASE I: Develop a prototype directional, steerable transducer compatible with an arbitrary 5-kHz band located in the 8- to 20-kHz acoustic spectrum. Examine the issue of tilt and motion sensitivity. Participate in a Navy-conducted sea experiment where the transducer will be evaluated using the U.S. Navy telesonar testbed.

PHASE II: Refine the transducer design for reduced cost, improved performance, high reliability, and ease of manufacture. Implement an appropriate strategy for tilt and motion immunity or compensation. Incorporate a means for true bearing determination. Use TRANSDEC or equivalent facilities for engineering development and calibration. Use Navy-provided opportunities for critical engineering sea tests. Show that the transducer can be mass-produced at a unit cost below $1,000. Integrate the transducer with a commercial acoustic modem and demonstrate performance.

PHASE III: Produce a commercial acoustic modem product based on the transducer technology.

COMMERCIAL POTENTIAL: This technology will improve undersea acoustic communications and other acoustic signaling. Commercial markets include oceanography, recreation, oil exploration, undersea mining, navigation, and climatology.

REFERENCES:
1. K.E. Scussel, J.A. Rice and S. Merriam, "A new MFSK modem for communication in adverse underwater channels," *Proc. IEEE Oceans'97*, Halifax, Nova Scotia, Canada, October 1997.
2. D. Porta, "Underwater acoustic communications," *Sea Technology*, Vol. 39, No. 2, pp. 49-55, February 1998.

KEY WORDS: undersea acoustics; acoustic communication; undersea networks; telesonar; acoustic lenses; sonar; acoustic arrays; transducers; electroacoustics

N99-012 TITLE: <u>Engineering Modeling of Cable Spans and Bend Radii for Cables and Pipes Laying on Irregular Bottoms</u>

SCIENCE/TECHNOLOGY AREA: Communications, command and Control

OBJECTIVE: To develop an analytical/numerical tool that will allow the user to have a true and accurate representation of a cable's shape as it lays on an irregular bottom terrain, including the unsupported spans and points of contact at the bottom, as well as the bend radii developed at the contact points (to compute induced stresses).

DESCRIPTION: Both the Navy and the commercial industry have a need to develop a stand alone, user-friendly, Windows NT based computer program that will allow the user to calculate quickly the locations and lengths of free spans as well as the bend radii for cables and pipes laid on an irregular bottom terrain. As the cable is laid over the ocean bottom, it will bend over obstacles, and its free spans will become a strong function of the bottom roughness. Given the values of water depth along specific bottom tracks, cable properties (wet weight and bending stiffness), and cable bottom tension, the program would determine the lengths and locations of the spans and the bend radii.

PHASE I: Develop the algorithms necessary to numerically determine locations and lengths of free spans as well as the bend radii for cables and pipes laid on irregular bottom terrain. Newly developed algorithms must be fast enough to compute solutions in almost real-time on a standard PC-based computer. Application of this technology to reduce time during at sea survey operations is one of the goals of this project.

PHASE II: PHASE I algorithms will be incorporated into a PC-based computer program modified to incorporate the effects of various types of in-line cables and in-line bodies typical of ASW cable systems. Results predicted by the program will be rigorously validated with experiment data.

PHASE III: Develop naval applications of the program, such as anti-submarine warfare operations.

COMMERCIAL POTENTIAL: The commercial sector will benefit from this because it will reduce the time taken in the selection of appropriate cable and pipeline routes. As the survey is progressing, the user could simulate the lay of his specific cable along different tracks and determine if this tool can be useful in establishing the tension the cable should be laid along different portions of the lay in order to minimize suspensions.

KEYWORDS: cable bends, cable shape, cable spans, cable stresses and radii computation

N99-013 TITLE: <u>Non-Explosive, Electrically Initiated Linear Shape Charge Technologies for Salvage and Obstacle Clearance Operations</u>

SCIENCE/TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Develop and demonstrate solid fuel/water compositions and methodology for electrically initiated non-explosive linear shaped charges.

DESCRIPTION: The US Navy has the mission to conduct develop and deploy technologies for a rapidly deployable, chokepoint salvage clearance system, and to develop the ability to conduct rapid destruction of obstacles in surf and beach areas. Recent studies have shown that it may be possible to develop non-explosive, electrically initiated reactive systems which are capable of generating energy release levels and rates characteristic of explosive systems. This effort would develop this technology, and design and demonstrate a non-explosive, electrically initiated prototype linear shaped charge device which has the potential to address these mission needs.

PHASE I: Identify candidate reactants and configurations. Conduct thermochemical analyses and trade-off studies of candidate fuel/oxidizer systems, electrical energy and power requirements. Fabricate test samples and perform essential tests for measurement of the pressure of reactants activated immediately by energetic electrical pulses.

PHASE II: Optimize candidate fuel/oxidizer formulation and solid configurations. Test activation and initiation thresholds and outputs. Optimize peak pressures and pressure-time histories for shape charge applications. Conduct tests to determine and optimize metal-driving capabilities. Obtain the equations of state. Design shaped charges liners to optimize performance for an electrically-activated system. Test charge/line configurations to verify that the performance meets prespecified requirements. Build and test a power unit prototype capable of adequately activating the reactive system. Verify its ability to function continuously in appropriate environments. Develop and demonstrate a cost-effective prototype system.

PHASE III: Transition technology into 6.2/6.3 Logistics and Mine Warfare programs for logistics and obstacle clearance applications, NAVSEA 00C Salvage and Diving program; and salvage and demolition programs for industrial and civil engineering applications.

COMMERCIAL POTENTIAL The technology developed under this effort can be used exploited by the commercial demolition, salvage, and mining industries. Currently large amounts of explosive bulk and shaped charges are used to demolish large structures such as high rise buildings and sea-borne oil platforms, and very tedious and difficult torching operations are used in ship salvage operations. This technology promises to replace these very dangerous operations with safer, more efficient, non-explosive ones. It will also substantially reduce the hazards currently associated with the storage and transportation (both by land and sea)of thousands of pounds of explosive devices currently required for these operations.

REFERENCES:
1. A.A. Shidlovskij; “Explosive Mixtures of Water and Methanol with Magnesium and Aluminum”, J. Prikl. Khimii, 19, 371 (1946) (Translated by Rosner and Holden NSWCWOL TR-77-163, Dec 1977)
2. W.C. Tao, A.M. Frank, and R.E. Clements; “The fundamentals of Metal Combustion in Composite Explosives Revealed by High Speed Microphotography”, Proceeding of the Nith International Symposium on Detonations, (Aug, 1989), pp 641.
3. W.M. Lee, D.L. Demske, and P.J. Miller; “Optically Measured Temperature Profile of a Condensed Aluminum-Water Medium undergoing a Fast Chemical Reaction”, Shock Compression of Condensed Matter, Elsevier, 1992, pp 741.

KEY WORDS: electrically activated reactions; pulse formed networks; linear shaped charges; salvage; obstacle clearance; logistics

N99-014 TITLE: Development of Advanced Electrode Materials for Rechargeable Lithium Batteries

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: Synthesize, characterize and demonstrate novel cathode materials of high energy density for electrochemical power sources for undersea vehicle propulsion which will provide significant performance improvement over the present state-of-the-art silver/zinc (Ag/Zn) batteries.

DESCRIPTION: Rechargeable Ag/Zn batteries are currently used in a wide variety of Navy applications including undersea vehicle propulsion in the Deep Submergence Rescue Vehicle (DSRV), the MK30 Torpedo Target, the SEAL Delivery Vehicle (SDV) and the Advanced Swimmer Delivery System (ASDS). These cells have excellent power capabilities, but mission duration is limited by their energy. Nevertheless, Ag/Zn batteries at present have the highest energy density of any commercially available battery. While other electrochemistries have been under development by the Navy to increase energy density (1,2), cathode materials that have theoretical energy densities of 1500-1750 Wh/Kg are now sought to be used in cells of even higher energy densities. Against a lithium metal anode, cathodes with 300 Ah/kg at 5 V or 550 Ah/kg at 3 V, with little, if any, fading on cycling, would be candidates. Intercalating oxides remain strong candidates, and a recent review has shown how structural and chemical engineering of these can lead to improved performance (3). Candidates other than the oxides also have been identified, such as nickel Chevrel-PHASE sulfides (4). While this SBIR initially addresses high-energy dense cathodes, materials of high voltage (such as the 4.9 V $LiNiVO_4$ (5)) subsequently will need to be screened for the stability of proposed electrolytes against them (as was done, for $Li_{1+x}Mn_2O_4$ (6)).

PHASE I: Employ a theoretical basis supported by the technical literature to suggest improved cathode materials and then synthesize and electrochemically characterize candidate materials. Cycling ability must be demonstrated, but electrolyte optimization need not be accomplished in this PHASE. Select suitable techniques to characterize the materials and enable reproducible preparation. Demonstrate the material's performance using laboratory-type cells.

PHASE II: Perform screening tests to optimize the electrolyte composition and other cathode components such as binders and/or conductive diluents. Build an adequate number of small (~1 Ah) cells to demonstrate the system's performance as functions of temperature, rate, and physical parameters of the cathode such as thickness and density.

PHASE III: Scale-up cell size to retrofit to a present Navy application, such as for propulsion of the SDV. Demonstrate as single cells and as batteries of 4-6 cells. Subsequently demonstrate as full-scale battery for a land-based test.

COMMERCIAL POTENTIAL: This battery could be applied to power commercial surface and undersea marine vehicles and would be a candidate for land-based electric vehicles.

REFERENCES:

1. C. J. Kelly, *Proc. 5th Workshop for Battery Exploratory Development*, June 30 - July 3, 1997, Sponsor, Office of Naval Research; Coordinator, High Energy Battery R&D Group, Naval Surface Warfare Center, Carderock Division, p. 175.
2. H-C Shiao, H-P Lin, and K. S. Nanjundaswamy, *Ibid.*, p. 181.
3. P. G. Bruce, *Chem. Comm.*, 1997, 1817.
4. M. Wakihara, H. Ikuta, and T. Uchida, *J. Power Sources,* 43-44, 651 (1993).
5. G. T. K. Fey, J. R. Dahn, M. J. Zhang, and W. Li, *Ibid.*, 68, 549 (1997).
6. D. Guyomard and J. M. Tarascon, *Ibid*., 54, 92 (1995).

KEY WORDS: cathodes; batteries; electrochemistry; high-energy; undersea; power;

N99-015 TITLE: Carbon Nanotube Composites for EMI Shielding

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: This program seeks to develop a carbon nanotube (single or multi-walled) composite that is strong, light wieght, electrically conducting, and able to shield electronic components in Navy aircraft and ships. It is envisioned that carbon nanotube composites will provide the basis for light wieght structural shielding of transmitted EMI.

DESCRIPTION: Navy platforms incorporate a variety electronic systems which emit and which can potentially be adversely affected by a variety of electromagnetic frequencies. Metals which are good conductors, such as copper, are often the basis of for shielding equipment from EMI. These materials also have the advantage of being structurally robust. The disadvantages are in wieght and the ability to readily mold and shape for required usage. Recent advances in carbon nanotube science and technology provide a unique opportunity to develop new classes of structural and electronic materials with properties ideal for EMI shielding applications. Multiwalled carbon nanotubes have been available for some time and more recently researchers are now able to provide workable quantities of single walled nanotubes. The SWNT have been predicted to have tensile strengths 40-100 times that of steel yet at 1/6 the weight. These SWNT nanotubes also have extraordinary electrical conductivities rivaling that of copper. Combining the properties of high conductivity with robust structure provide a opportunity for a new type of EMI shielding materials. Efforts will identify specific shielding requirements at a given frequency range where a nanotube based composites will have a significant improvement (wieght, thickness) over other shielding methods.

PHASE I: Identify and synthesize appropriate nanotube/polymer combinations to address shielding requirements over frequency range proposed. Activities should, through modeling and/or experiment, identify the potential for achieving high strength/light weight, highly conductive composites. Ideally the composite properties will be isotropic and will ultimately focus of use of the single walled nanotubes.

PHASE II: Activities will focus on polymer/nanotube interactions and optimization. This can include but is not limit to studies of phase segregation, rheology, and chemical interactions of polymer and nanotube. In addition it is envisioned that the PHASE II activities conclusively demonstrate test pieces with significant enhancement (wieght, thickness, frequencies) in EMI shielding capabilities.

PHASE III: Efforts will focus on cost analysis/reduction and testing of composites for Navy application. Testing included effectiveness against EMI as well as reduction of EMI signature combined with demonstration of robust mechanical properties. Large composite strength tests will be undertaken.

COMMERCIAL POTENTIAL: The commercial aerospace industry would benefit of conducting, lightweight, high strength composites for structures and electronic systems. It is also envisioned that these materials will be suitable for EMI shielding in consumer electronics. From a purely mechanical perspective, in the area of personal armor there would be significant commercial potential in alternatives to Kevlar.

KEY WORDS: carbon, nanotube, composite, conductors, high strength, polymers

REFERENCE: MIL-STD-461D provides a variety requirements for various EMI shielding considerations. This reference is meant only as a guide, not as a specification for this topic.

N99-016 TITLE: Rare Earth Doped Polymer Waveguide Amplifiers for High Data Rate Networks

SCIENCE/TECHNOLOGY AREA: Command, Control and Communications

OBJECTIVE: To meet the needs for future Naval systems, such as PHASEd array radar, that require ultra-high (> 10 Gbps) information data transfer rates, high performance optical fibers are required. Polymer Optical Fibers (POFs) are tough and have a high aperture, but decreased loss and improved signal amplification are required. To realize high performance, compact, rare earth doped POF amplifiers are needed. The objective of this effort is to develop dye doped POF's with high concentrations of erbium ions and long excited-state lifetimes so as to enable the fabrication of amplifiers that can be integrated with waveguide switches and multiplexers. Ideally, the fibers would be fluorocarbon based to minimize loss.

DESCRIPTION: Fiber optic networks require ever expanding orders of magnitude increase in signal carrying capacity and processing. Toward these ends, rare earth doped glass optical amplifiers have been developed, as optical signal transmission over multikilometer distances requires periodic signal amplification. Existing 1550 nm amplifiers (erbium-doped fiber amplifiers, or EDFAs) employ many meters of special erbium-doped glass optical fiber pumped by 980 nm diode lasers so that stimulated emission at 1550 nm occurs. The long path lengths are a consequence of the small concentration of erbium oxide achievable in glass fiber. Proposed efforts shall address erbium-containing polymers with a target concentration of 10^{21} ions/cm^3, sufficient to enable the fabrication of waveguide amplifier devices on a length scale of a few centimeters. Critical to performance is the erbium excited state lifetime, which must be at least one millisecond. In organic materials, the primary mechanism for lifetime shortening is the coupling of electronic energy into vibrational energy of the host material via overtone transitions. Material design and synthesis must be accomplished so that quenching is eliminated. The amplifiers should be compatible with network transmission rates in the range of 1-10 Gbps and provide gains greater than 10-20 dB. The amplification device should be compatible with commercial high-performance protocols. A ruggedized form of the amplifier should be capable of operating over the military temperature range.

PHASE I: Synthesize a thin film material by organic methods whose erbium ion concentration is on the order of 10^{21} ions/cm^3 and whose ion excited state lifetime is on the order of 1 ms. Demonstrate feasibility of a rare earth doped polymer optical amplifier to include evaluation of optical properties, gain, temperature performance, cost, size, and weight of the amplifier component. Evaluate the temperature performance of the amplifier. Evaluate and select a low cost protocol chip.

PHASE II: Develop and demonstrate a rare earth doped polymer optical amplifier prototype, including evaluation of gain, throughput, size, weight, power dissipation, and performance over the military temperature range.

PHASE III: Independently or with a major manufacturing corporate partner, develop fabrication methods suitable for low-cost manufacturing and production of rugged amplifier device components for use in commercial and military applications.

COMMERCIAL POTENTIAL: A large market is anticipated for polymer optical amplifiers for economical, high bandwidth voice, video, and data transmission.

KEY WORDS: optical fibers, amplifiers, rare earths, doping, polymer, erbium

N99-017 TITLE: A Large Area Hidden Corrosion Detection Device for Aircraft

SCIENCE/TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop a device for quickly and economically detecting hidden corrosion in multiple layer aircraft structures.

DESCRIPTION: Multiple layer structures, including repaired areas, tear straps, doublers, fuselage reinforcements, multi-layer joints, skin to core areas, and lap splice joints are common in Navy and commercial aircraft. Current techniques for detecting hidden corrosion in clean or painted multi-layer aircraft structures are expensive, time consuming, cover small areas (are essentially point-by-point), and are often unreliable and controversial in their indications. Crack detection is limited to the surface and second layer of a known structure. Recording defect images of a large area is possible, but the inspection setup is time consuming, equipment is expensive, analysis is difficult, and sizing and location analysis is unreliable. A simple, quick, inexpensive and reliable large area (as opposed to point-by-point) method of nondestructive testing of multiple layer structures is needed as a maintenance tool. The device should be capable of detecting thinned fuselage structures and hidden corrosion in multiple layer structures with as many as five layers having corrosion attack at any interface. The device should be portable, hand operated and capable of data and decision logging. Complex scanning systems are undesirable for their size and/or potential operator training requirements.

PHASE I: Determine the basic physics and mechanics of the nondestructive evaluation of multiple layer aircraft structures. Demonstrate the feasibility of converting this technology into a simple, hand held inspection device.

PHASE II: Develop a working prototype inspection device. Evaluate device performance in terms of overall success in detecting different types of corrosion defects (i.e.: wall thinning, interface corrosion attack, inner or outer wall corrosion attack). Establish a database relating the inspection success rate to corrosion or defect type.

PHASE III: Under program office or industry sponsorship, conduct tests on a variety of different aircraft structures within the fleet.

COMMERCIAL POTENTIAL: A hand held inspection device with proven performance capability will have immediate application commercially. The aircraft industry will benefit in time and cost savings, as well as increased flight safety.

REFERENCES:

1. Rose, J.L., Rajana, K.M., Hansch, M.K.T., AUltrasonic Guided Waves for NDE of Adhesively Bonded Structures, Journal of Adhesion, Vol. 50, pp. 71-82, 1995.

2. The First Joint DOD/FAA/NASA conference on Aging Aircraft, Ogden, Utah, July 8-10 1997.

KEY WORDS: Corrosion, inspection, aircraft, ultrasonic, nondestructive, joints

N99-018 TITLE: Formulation of Underwater Coating for Hull Touch-Up Repair

OBJECTIVE: Develop a polymer coating combination that will be immiscible with seawater and fresh water, and would be cohesive enough to not Atadpole or break away during application.

DESCRIPTION: Underwater hull paint touch up repairs are normally performed by divers. When applying the paint, it is normally done above the diver's head. The coating being applied would normally disintegrate or break away from the paint brush or application gun, thus contaminating the water, causing the water to becomes cloudy making it difficult for the diver to see and complete the mission. It would also contaminate marine life. This will not meet the EPA standard for clean water. Development of a new polymer combination would consist of no solvents (100% solids) and no heavy metals with good cohesive strength, and will have the ability to meet VOC requirements regulated by the Federal and State government. It would be user friendly, and not toxic site disposable. The transfer efficiency will need to be extremely high to meet these demands.

PHASE I: To develop a coating system using a modified epoxy with curing agent system, that may be of the polyamide and polyamine functional groups, that can be applied under water. If this system is proven to be feasible, it should be able to fill in pits in steel and repair any damage to steel underwater. It should also be capable of being painted over with a different coating system while in drydock.

PHASE II: Optimize the potential formulation developed and integrate the technology into a working pilot system for underwater hull touch up repairs.

PHASE III: The use of underwater hull touch up repair coatings could extend to all classes of ships and submarines.

COMMERCIAL POTENTIAL: This technology would show promise for use on commercial sea vessels as well as Navy vessels. The use of this technology would provide considerable cost savings in reduced drydocking time for hull paint touch up repairs. It could be used to touch up dock block areas on a vessel after it has been removed from drydocking.

REFERENCES:

(1) Deep-Water Production Corrosion Technology; by R.D. Kane, S.T. Tebbal, M.S. Cayard, and H.R. Hanson; Materials Performance Magazine; April 1998, Volume 37, Number 4, page 54.

(2) Case Histories- Salt Water and Underwater; by Colin Allen; Corrosion Management Magazine; August 1995, Volume 4, Number 3, page 8.

KEY WORDS: Environmental, clean water, dock block, drydock, underwater coating, non-contamination.

N99-019 TITLE: Actuators and Transducers from Single Crystal Piezoelectric Materials

SCIENCE/TECHNOLOGY AREA: Materials

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

DESCRIPTION: Recent research results have established that relaxor-based single crystal piezoelectric 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 sonar and medical diagnostic transducers, and for electromechanical actuators that are used in vibration control applications, especially aboardships. To utilize these single crystals, cost-effective innovative device design and fabrication methods are sought which will produce transducer and actuator applications with revolutionary performance; e.g., targeting bandwidth increase in excess of one octave and a strain level of 0.5% for the expansion of bandwidth of existing transducers, miniaturize current devices to provide high power sources or vibration control for signature reduction.

PHASE I: Demonstrate a device design and prototype fabrication that make use of piezoelectric single crystals with high electromechanical coupling and high actuator authority.

PHASE II: Develop a cost-effective device fabrication method and demonstrate performance in prototype device configurations.

PHASE III: Manufacture acoustic transducers and electromechanical actuators to be incorporated into a current Naval system, and demonstrate the revolutionized high performance over current systems or miniaturize the current systems.

COMMERCIAL POTENTIAL: These high performance devices will have application as broadband ultrasonic transducers used in medical diagnostic imaging, and as 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," IEEE Transactions on Ultrasonics Ferroelerctrics and Frequency Control, Vol.44, No. 5, 1140-1147 (1997).

KEY WORDS: Piezoelectric; Single Crystal; Acoustic Transducers; Electromechanical Actuators; Relaxor Ferroelectrics; Ultrasonic Transducers

N99-020 TITLE: Active Control Using Microelectromechanical Systems (MEMS)

SCIENCE/TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop and demonstrate active flow control systems using micro-sensors /actuators and electronics.

DESCRIPTION: Active control approach to reduce noise and vibration has received a great deal of attention and has achieved a certain level of practicality. Recent advances in control algorithms, MEMS-based sensors, actuators, and electronics further provide the control community an opportunity to tackle the more challenging flow control problems. Examples include flow control around airfoil, stator wake management in rotating machinery, and control of shear layer in jet flow, etc. The success of flow control provides enhanced performance and reduction of high cycle fatigue in rotating machinery. Furthermore, MEMS technology provides miniaturization of the active control system, which has potential to reduce the cost and weight of the overall active control systems. PHASE I: Feasibility Study: Examine various novel micro-sensor/actuator devices, electronics, and robust control algorithms; and develop an active flow control concept. Based on results from the feasibility study, select application(s) for further development and demonstration.

PHASE II: Develop and demonstrate active flow control systems. These efforts will be conducted in the laboratory with prototype models for the application(s) selected in PHASE I.

PHASE III: Transition MEMS-based active flow control methodology to practical and engineering problems.

COMMERCIAL POTENTIAL: The commercial applications include flow control devices/components in rotating machinery, such as aircraft engines, compressors and pumps, as well as aircraft flaps and wing, and helicopter rotary blades. Most important, this SBIR effort develops a design process to miniaturize active control systems, which has positive impact on the cost, size, and weight of the control systems.

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1. Bossche, A., "MEMS Packaging: State of the Art and Future Trends," Proceedings of the 5th SPIE International Symposium on Smart Structures and Materials, Vol 3328, March 1998.
2. Chase, G., et al., "MEMS-Based Control of Structural Dynamic Instability," 1997 International Mechanical Engineering Congress & Exposition, Dallas, Texas, November 1997.
3. Ho, C. M., "MEMS for Fluidic Controls," 1997 International Mechanical Engineering Congress & Exposition, Dallas, Texas, November 1997.
4. Kuo, S. M. and Morgan, D. R., *Active Noise Control Systems*, John Wiley & Sons, New York, 1996.

5. Miller, M. B., et al., "Optical Fiber-Interconnected MEMS Sensors and Actuators," Proceedings of the 5th SPIE International Symposium on Smart Structures and Materials, Vol 3330, March 1998.

KEY WORDS: active control; MEMS; micro-sensors; micro-actuators; flow control; adaptive structures and systems

N99-021 TITLE: Fuels for Pulsed Detonation Engines

SCIENCE/TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: Develop methods for synthesis of new fuels, chemical modification of conventional fuels or energetic fuels that can be dissolved in conventional fuels, specifically suited for use in pulsed detonation engines (PDE).

DESCRIPTION: Pulse detonation engines offer the capability of propelling weapons for subsonic to supersonic speeds without ejecting boosters, and with fewer moving parts. Development of the science and technology base for PDE has been initiated. A number of traditional fuels and oxidizers have been tried in PDEs; Gas fuels perform adequately in engines, but are not amenable to weaponization. Liquids have the energy and density characteristics that make them candidate for PDE fuel and provide cooling for the PDE detonation tube. New fuel or fuel formulations are required to meet the challenges offered by PDEs, such as good volumetric energy density, provision of endothermic cooling, quick vaporization and mixing with air, and most importantly, detonation without a long detonation tube.

PHASE I: Develop synthesis methods for new fuel and fuel formulations that are amenable to detonation. Develop fuels that will dissolve in conventional fuels and enhance detonation characteristics.

PHASE II: Develop methods for large-scale synthesis or production of the new fuel(s), fuel formulation(s) or fuel additive(s). Perform laboratory scale detonation characterization in actual PDE tube.

PHASE III: Develop demonstration plant technology for the production of selected PDE fuel, fuel formulation or additive.

COMMERCIAL POTENTIAL: Stationary PDE technology for electric power generation have been discussed. The developed product could be used in such systems.

KEY WORDS: Detonation, high energy fuel, vaporization, propulsion

N99-022 TITLE: Self-Contained Pumps and Machinery

SCIENCE/TECHNOLOGY AREA: Propulsion and Power

OBJECTIVE: Develop self-contained pumps based on the use of newly developed Active materials (Smart materials) concepts.

DESCRIPTION: Active (Smart) materials offer a unique opportunity for developing self-contained pumps for various Navy and civilian applications. Recent developments in active materials such as those activated by magnetic or electric fields, are providing phenomenal activation strains at very high frequencies. The combined high frequency and high strain could be utilized in developing new pumps with unique properties. The efficiency of such self-contained pumps could also be very high because of the elimination of traditional design constraints. Due to the reduction of the number of moving parts and the high operating frequency they would generate very low noise. Active (smart) materials are a class of materials, which have the capability to both sense and respond to environmental stimuli. Previous DOD programs have provided theory, design tools, characterization of collective behavior and integration technology. These programs also fostered development of the active constituents such as shape memory alloys, electrostrictive ceramics, magneto-stricitve alloys, magneto memory alloys, and fiber optic sensors. Self-contained pumps should exploit revolutionary concepts of direct electro or magneto-hydro mechanical energy conversion. Several concepts of application of smart materials in MEMS type pumps, may also prove applicable to large size pumps. Innovative new actuators (linear, torsional, continuous, ratcheting, inchworm, bimorph, flextension and other concepts including multi-axis actuators) which exploit the unique properties of active (smart) materials or a composite/hybrid of active materials could be the basis for developing self-contained pumps. This technology could provide highly compact pumps, with high reliability, efficiency and controllability. Interest is in self-contained pumps for performing various functions currently performed by various types of positive displacement pumps.

PHASE I: Develop several concepts for self-contained pumps, integrate active materials (smart materials) and demonstrate functionality.

PHASE II: Down select and build prototype self-contained pump and investigate efficiency, acoustics and other operational parameters.

PHASE III: Refine efficiency and develop program for practical cost effective application to a wide range of fluids, pressures, flow rates and acoustic parameters.

COMMERCIAL POTENTIAL: In addition to Navy ships and submersible applications, self-contained pumps should have a tremendous market in automotive (e.g. fuel pumps, power steering pumps, brake booster pumps), passenger aircraft, aerospace, and marine systems, and the chemical and petroleum industry. A potential civilian application could be in artificial heart pumps, medicine delivery (probably MEMS) and other medical devices.

REFERENCES: SPIE Annual International Symposium on "Smart Structures and Materials" held in San Diego CA, Proceedings, March 1996, 1997, 1998.

KEY WORDS: Self-contained pumps, actuators, smart materials, active materials, magnetostricitve materials, Terfenol, piezo-ceramics, PZT, shape memory alloys, magnetic memory alloys.

N99-023 TITLE: Standardized Interconnect Technology for Integrated Power Modules and PEBB

SCIENCE/TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop an interconnect system containing standardized bus bars that enables a `snap together' approach taking standard power electronic components and subsystems and assembling them into a fully operational three PHASE system such as an Inverter, motor controller, converter or power supply.

DESCRIPTION: Power Electronics technology is characterized by application specific systems development resulting in significant engineering costs embedded in each new power electronics product. The focus in power electronics has been in the development of discrete components optimized for cost, performance and market. To address this situation, an new IEEE standards committee(1) has developed “recommended practices” to address the integration of components, subsystems, power electronic modules and systems via interconnections .

PHASE I: Design and Develop an integrated bus bar system that is suitable for integrating all the components that go into making up a three - PHASE Inverter between 30 to 100 kW. Show how this approach can be used to optimize performance and minimize and reduce total system input impedance. Show how this meets and exceeds the recommended practices of IEEE 1461- Power Electronic Module Interfaces.

PHASE II: Develop, characterize and test a 3-PHASE Inverter of 100 kW using standard power electronics components and modules based on the bus interconnect technology. Develop and incorporate a communication system for internal and external control of the power electronics and the control electronics.

PHASE III: Design, Demonstrate and Fabricate fully function power electronics systems between 30 and 250 KW using the above concepts that integrate all the above approaches from commercial off the shelf and PEBB module components. Demonstrate multifunctionality, programmability and “plug and play” capability with a suitable user interface.

COMMERCIAL POTENTIAL: This system can be applied to any power electronics environment from motor controls to the power utilities. This proposal will enable the development of low cost high density integrated power electronic module systems (PEBB)

REFERENCES:
1) IEEE Standards Committee 1461; Power Electronic Module Interfaces; http://grouper.ieee.org/groups/1461/index.html
2) PEBB WEB SITE: pebb.onr.navy.mil

KEY WORDS: interconnection, bus bar, power electronics, PEBB, “plug and play”

N99-024 TITLE: Nondestructive Evaluation of Composite Core Structures

SCIENCE/TECHNOLOGY AREA: Materials and Processes

OBJECTIVE: Develop a nondestructive inspection technique to detect delaminations, disbonds, and foreign material in composite core structures.

DESCRIPTION: In order to achieve weight savings and signature reduction, the US Navy is increasing the use of multi-layer composites in the super structure of surface ships, for example, the AEM/S system and LPD-17. For structural strength, these composites often contain multiple balsa wood or polyurethane form cores with glass reinforced laminates ; e.g., E-glass woven rovings in polyester resin. Traditional NDE techniques, ultrasonic and radiography, are unable to detect critical size voids, disbonds, kissing disbonds, delamination (50-300 mm in panels, 5-50 mm in T and top hat joints), and porosity at the skin-to-core bond lines. Furthermore, no current inspection technologies can inexpensively and reliably penetrate to inner layers of the foam and wood structures for inspections. Thus, the Navy requires a reliable technique for inspection large section layered composites.

PHASE I: Investigate techniques to perform detection of delamination, disbonds, kissing disbonds, and porosity in multi-layered composites. Identify limitations of techniques as applied to in-the-field inspections.

PHASE II: Develop prototype inspection equipment and quantify limitations of hardware. Develop inspection procedure. Identify resolution (minimum size detectable) of technique for disbonds, kissing disbonds, delaminations, and porosity. If possible, the developed technique should identify the layer (depth) at which the defect is located.

PHASE III: Transition the inspection equipment to the Navy, for example, the Norfolk Naval Shipyard and the Naval Surface Warfare Center, where the system can be demonstrated on the AEM/S system and/or LPD 17. Train Naval personnel on the inspection technique.

COMMERCIAL POTENTIAL: This technology has direct application to commercial shipyards, for example, Bath Ironworks, Avondale Industries, General Dynamics, and Ingals Shipyard. In addition, this technology is applicable to inspection of composite structures aboard aircraft at Boeing, and Lockheed Martin.

REFERENCES:

1. J.K. Easter, N. Qaddoumi, R. Zoughi, L.M. Brown, J.J. DeLoach, "Preliminary Results of Detecting and Locating Defects Under Triangular Thick Composite Structural Members", in Nondestructive Evaluation of Materials and Composites II, Steven R. Doctor, Carol A. Lebowitz, Geroge Y. Baaklini, Editors, Proceedings of SPIE Vol. 3396, pp. 129-134 (1998).

2. N. Quaddoumi, S. Ganchev, and R. Zoughi, "Preliminary Results of Non-contact Detection and Depth Determination of Disbonds in Low Permitivity and Low Loss Thick Sandwich Composites", Review of Progress in Quantitative Nondestructive Evaluation, Vol. 15, Edited by D.O. Thompson and D.E. Chimenti, Plenum Press, New York, pp. 687-692 (1996).

3. J.J. DeLoach, Jr., and C.A. Lebowitz, "Evaluation of Techniques for Inspecting the Advanced Enclosed Mast/Sensor System," CARDIVNSWC-TR-61-96/04 September 1996.

4. J. Sumpter, "Defect Tolerance of GRP Ships," International Conference Advances in Marine Structures III, Session 4, Paper 12, DERA Rosyth, UK 20-23 May 1997.

KEY WORDS: thick-section composite, core structures, disbonds, delaminations, nondestructive evaluation, composite joint inspection

N99-025 TITLE: Medical Data Fusion Watchboard

SCIENCE/TECHNOLOGY AREA: Computers/Software

OBJECTIVE: Enable medical care providers, support personnel, and remote command to fuse casualty related data within a medical treatment facility to track casualty movement and assess the medical situation.

DESCRIPTION: A number of efforts are underway developing personnel status monitors capable of alerting medical resources if the soldier’s vital signs indicate an injury. Other devices are available which could be used to track the movement of casualties within a medical treatment facility. In addition, there are a host of other data available that are relevant to medical care and medical readiness. This effort would fuse this information on a real-time electronic watchboard, so that medical care providers, support personnel, and remote command locations could visualize the medical care situation. This type of visualization tool could be used to help allocate medical and support resources to the most appropriate locations.

PHASE I: Identify the types of information available from various personnel monitoring devices and databases. Create a proof of concept prototype watchboard that displays a floor plan, shows the location of each casualty, and provides mechanisms to access casualty relevant data.

PHASE II: Work with users to design the specific user interface. Provide support to import and use pre-drawn CAD files. Provide the capability to add various annotations to the floor plans and allow the user to simultaneously display multiple types of casualty data. Add the ability to generate and display summary information. Define a set of test scenarios varying the location, status, and number of casualties. Develop and test the Data Fusion Watchboard in concert with medical care providers and medical planners. Where appropriate, implement live connections to data required by the system.

PHASE III: Produce graphical front ends tailored to medical care providers and medical planners (DoD/Commercial). Integrate with existing military and civilian systems.

COMMERCIAL POTENTIAL: This system could be used by civilian medical care facilities and local resource planners.

KEY WORDS: Medical; Data Fusion; Patient Tracking; Watchboard; Planning; Real-Time

N99-026 TITLE: A Case Resource for Cognitive Task Analysis

SCIENCE/TECHNOLOGY AREA: Manpower and Training Systems

OBJECTIVE: Provide a computerized resource of case examples of cognitive task analyses to aid users in addressing new task analysis problems.

DESCRIPTION: The changing nature of modern work gives increasing importance to the mental or cognitive aspects of jobs that cannot be directly observed and analyzed by others. Consequently, for purposes of training design, the effective design of computer systems to support work, task allocations to team members and related applications, "cognitive task analysis" is increasingly needed. A NATO Study Group on Cognitive Task Analysis has concluded that the state of the art is not consistent with any cut-and-dried prescriptive or textbook approach to cognitive task analysis. Typically, a successful and useful cognitive task analysis involves a complex orchestration of several research techniques to obtain the necessary information to support the target application. It is felt that the most useful aid to those faced with a need to conduct a cognitive task analysis would be a convenient resource providing access to cases of prior cognitive task analyses that were considered successful in achieving the desired result. Users could identify past cases similar to their own problem in dimensions such as the domain of application (eg. Maintenance, tactical decision-making, navigation), the type of application (training, system design, certification of competence) and the human and financial resources available. Drawing upon upon related past cases, users could then develop a plan for their own cognitive task analysis problem, applying a case-based reasoning approach. Ideally, the case resource to be developed under this project would be computerized and provide access to the full text of articles, books, or book chapters describing the cases; the design should provide for continuing updates through the addition of new cases.

PHASE I: Conduct research to determine appropriate indexing categories and/or dimensions for cases. Conduct research to locate prospective cases of cognitive task analyses, aiming to accurately estimate the total size of the currently available population of cases. Design and prototype the case resource tool and investigate the feasibility and cost of obtaining rights to the full descriptive texts. Investigate the availability of computer aids to aspects of the cognitive task analysis process and investigate the feasibility and cost of obtaining rights to incorporate such tools in the resource.

PHASE II: Develop the case resource tool. Test with a sample of prospective users and refine appropriately. Assess helpfulness and market potential of cognitive task analysis case resource.

PHASE III: Further develop as necessary for commercialization and commercialize.

COMMERCIAL POTENTIAL: This product should have modest commercial potential if appropriately marketed to academics and consulting firms in the areas of industrial psychology and system development. Increasing demand for cognitive task analyses is to be expected from both DoD and commercial industrial customers. Their contractors are going to need the assistance of a resource such as this to meet the growing demand.

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2. B. Kirwin & L.K. Ainsworth (Eds) (1992) *A Guide to Task Analysis*. London: Taylor & Francis.
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KEY WORDS: cognitive task analysis; task analysis; user-centered design; instructional design; case-based reasoning; knowledge engineering; expert systems.

N99-027 TITLE: User-friendly techniques for creating realistic models of Human Behavior Under the Stress of Battle

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: The objective is to develop efficient, user-friendly techniques that can be used to extend and exploit current models of human cognition and performance to create computer generated forces (CGFs) that respond realistically to sources of battle-related trauma (e.g., suppressive fire, biological or chemical weapons, ionizing radiation, psychological stress) in distributed interactive simulations for military training and analysis.

DESCRIPTION: A major requirement for conducting effective training or analysis with distributed interactive simulations is to exercise with and against realistically behaving CGFs. Today's CGFs do not respond in the same way or with the same variability as do real combatants operating under the stresses of battle. Consequently, virtual or constructive simulations populated with currently available CGFs provide training of limited effectiveness and analytical results of limited validity. Preliminary demonstrations have shown that stress sensitive CGFs (SSCGFs) can be created (Pew and Mavor, 1998). What is now needed is the creation of techniques for generating SSCGFs that (1) are efficient and user-friendly; (2) enable the principled linkage of stress effects to specific cognitive and perceptual operations; (3) produce realistic ranges and types of variability in responses to stress across simulated individuals differing in training, experience, and other stress moderators; and (4) are extendable across a selected range of stressor types.

PHASE I: Based on a thorough understanding of the empirical and theoretical literatures on cognition and human performance and on the effects of stress on human behavior and on perceptual and cognitive operations, develop a conceptual framework for understanding human performance degradation under high stress. The framework must incorporate abilities, tasks, and behavior descriptions, and identify cognitive and perceptual sub-processes and behavioral outcomes effected by identified stressors. The framework must be compatible with DMSO's High Level Architecture and should exploit developments in its program on Conceptual Models of the Mission Space.

PHASE II: Use the framework developed in PHASE I to extend and exploit an existing model of human cognition and performance such as Soar, COGNET, ACT-R, or other executable model to create SSCGFs in both a combat operations and a decision making mode within a distributed interaction simulation environment proof-of-concept exercise, using selected stressors. Provide an assessment of the effectiveness of the resulting model with respect to its ease of application (user friendliness) and the realism of the nature and variability of stress effects it exhibits in the exercise, and modify the model as required to address identified usability and validity problems.

PHASE III: Apply and quantitatively evaluate the model emerging from PHASE II in a major distributed interactive simulation exercise within the Joint Countermine Operational Simulator (JCOS)/Extending the Littoral Battlespace (ELB)/Joint Medical Operations-Telemedicine combined ACTD demonstration.

COMMERCIAL POTENTIAL: When completed, SSCGF development software will provide the basis for creating synthetic entities that are responsive to the effects of a selected set of battlefield stressors. This accomplishment opens the door to simulating human responses associated with other highly stressful situations such as nuclear power or chemical plant operations, commercial aircraft operations, air traffic control, hostage negotiations, and natural disaster response. SSCGF extensions will enable modelers to account for fatigue, confusion, anger, and fear, which have hitherto not been represented in combat or disaster simulations. In addition, the use of SSCGFs in entertainment games and virtual reality arcades will make the computer driven opponents more exciting to confront.

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KEY WORDS: Stress; cognitive modeling; CGFs; DIS; simulation for training; battle injury.

N99-028 TITLE: Prognostics for Electric Actuation Systems

SCIENCE/TECHNOLOGY AREA: Aerospace Vehicles

OBJECTIVE: To develop new technologies for predictive diagnostics of next generation electric actuation systems (including the actuators, the control and power electronics, and the power management and distribution system)

DESCRIPTION: Electric actuation has currently reached the level of technical maturity that it may be used in military aircraft in the near future. The move to electric actuation will create new challenges in diagnostics and prognostics technology such as the increased integration between the flight control, electric power, and cooling systems. At the same time, increases in the amount of data that is available on-line and advances in prognostic technology make prognostics or predictive diagnostics an important technology to develop to predict and isolate failures for this type of system. The focus of this program should be on developing new software algorithm solutions such as neural networks, fuzzy logic, advanced statistical pattern recognition, model-based systems, and expert systems as opposed to adding additional sensors to current designs. Any proposed sensor technology must be low-cost, low weight, and low volume (e.g., micromechanical sensors). Another factor of importance should be avoiding false alarms.

PHASE I: The proposed prognostic technology shall be developed and demonstrated either in simulation or on available laboratory or flight test data for electric actuation system hardware components.

PHASE II: The contractor shall do additional technology development and design a software package to implement and test prognostic algorithms for electric actuation systems. The contractor shall perform a laboratory demonstration to show the ability of the algorithms to predict and isolate failures. This demonstration shall utilize, to the greatest extent possible, actual flight control hardware. Demonstration of the prototype system using a simulated data stream in lieu of actual hardware data will be considered marginally acceptable.

PHASE III: PHASE III will demonstrate the prognostic algorithms in a flight test program.

COMMERCIAL POTENTIAL: Electric actuation is currently being developed for a wide range of applications including aircraft, ground vehicles, robotic, and manufacturing. There is currently a strong demand for techniques that can predict failures in electric actuation hardware without the addition of expensive sensor technology. As a result, the software package should have strong commercial potential, if successful.

REFERENCES: More Electric F-18 Cost Benefit Study, Air Force Report: WL-TR-91-2093; Lessons Learned in Electrical Actuation Development for Flight Control Systems, Air Force Report: WL-TR-97-3069

KEY WORDS: prognostics; flight control; electric actuation; diagnostics

N99-029 TITLE: Fault-Tolerant and Intelligent Flight Control for Multiple Correlated Failures caused by Man-Portable Air Defense Systems (MANPADS)

SCIENCE/TECHNOLOGY AREA: Aerospace Vehicles

OBJECTIVE: To develop advanced technologies for fault-tolerant, intelligent, and reconfigurable flight control systems that can deal with multiple correlated failures caused by Man-Portable Air Defense Systems (MANPADS).

DESCRIPTION: Much of the fault-tolerance of current flight control systems is based on an assumption of random independent single failures that occur at different times. Similarly, much research work in intelligent and adaptive control has limited ability to deal with multiple simultaneous failure cases (e.g., simultaneous damage to a flight control surface combined with degraded sensor information). In contrast, the growing threat of Man-Portable Air Defense Systems, like SA-16's and Stinger missiles may cause multiple correlated failures in the flight control system. Multiple correlated failures may cause loss of aircraft despite the fact that the same combination of failures occurring at different times due to different causes would not cause loss of an aircraft. For example, in a triplex control system, it is possible that a multiple correlated failure would cause 2 degraded channels to vote out the single remaining healthy channel and cause a loss of aircraft and aircrew. This is a particularly challenging problem since there is so little theory to deal with this type of problem. Potential approaches to this problem could include adaptive control, robust control, intelligent control (such as neural networks and fuzzy logic) or advanced sensor technology. Theoretical development of approaches to identifying vulnerability for multiple correlated failures will also be necessary. This technology could also be used to deal with other potential causes of multiple correlated failures like a thrown turbine blade or mid-air collision.

PHASE I: The contractor shall develop and demonstrate their technology approach towards reducing the vulnerability of flight control systems to multiple correlated failures. This shall include limited simulation of algorithms and hardware approaches.

PHASE II: The contractor shall perform additional development of vulnerability reduction technologies and demonstrate the approaches to vulnerability reduction using high fidelity simulation and possibly either piloted simulation or limited real-time hardware in-the-loop laboratory demonstration. The contractor shall publish a design handbook for the application of these technologies to flight control systems and a an accompanying software package to implement an algorithm techniques.

PHASE III: The contractor shall do extensive piloted simulation and laboratory hardware-in-the-loop demonstration of the vulnerability reduction technologies.

COMMERCIAL POTENTIAL: There is currently concern within the commercial aviation community about the threat of MANPAD systems used by terrorists. This technology could also be used to deal with other potential causes of multiple correlated failures like a thrown turbine blade or mid-air collision. The ability to diagnose multiple correlated failures would also be of value in other industries with safety-critical control systems like the nuclear power industry.

KEY WORDS: flight control, vulnerability, multiple correlated failures, MANPADS

N99-030 TITLE: Adaptable Explosive Composition

SCIENCE/TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: To develop an energetic material having a controllable rate and magnitude of energy release.

DESCRIPTION: A need exists for an energetic material whose energy release rate and magnitude can be controlled to provide either high internal blast or high metal acceleration or muted output. This material is needed in conjunction with an adaptable ordnance technology program intended to develop a single ordnance package having capable of producing multiple kill mechanisms.

PHASE I: Generate concepts and mathematical models of candidate energetic materials. The use of multiple low energy detonators may be necessary to achieve variable output.

PHASE II: Formulate, synthesize and characterize small batches of adaptable explosive. Demonstrate adaptable output using small-scale hardware. Scale-up successful compositions to evaluate and identify production issues. Demonstrate accuracy of predictive mathematical models

PHASE III: Qualify successful compositions for DOD and Navy use. Transition data package to industry.

COMMERCIAL POTENTIAL: Technologies demonstrated under this effort have applications to commercial blasting, automotive airbags and universities study detonation physics.

KEY WORDS: explosives, energetic materials, internal blast, metal acceleration, collateral damage control, low energy initiators

N99-031 TITLE: Multiple Separable Penetrators

SCIENCE/TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: To develop technologies enabling multiple separable penetrators to function as a single penetrator assembly.

DESCRIPTION: A need exists for multiple rigid penetrators to be interlocked into a single large penetrator, as well as being easily separated from the large penetrator into discrete penetrators. This must be achieved using techniques and technologies that minimize the parasitic weight and component costs. There are no other restrictions to the approach taken. Novel mechanical and non-mechanical approaches are encouraged.

PHASE I: Generate concepts and demonstrate proof of principal using simplified hardware.

PHASE II: Develop and characterize the requisite technologies using full or subscale hardware. Develop and verify the accuracy of structural analysis tools to describe the penetration and separation mechanics.

PHASE III: Transition technology to Missile and Projectile program offices for potential inclusion in next generation penetrating weapons.

COMMERCIAL POTENTIAL: Technologies demonstrated under this effort will likely have applications to material joining and separating needs found in the space and automotive industries. This will create new markets for these types of technologies in the small business materials and electronics sectors.

KEY WORDS: Joining, separating, penetrators, materials, modeling, control

N99-032 TITLE: Prediction of Structural Response to Fragmentation/Blast/Firestarting Effects

SCIENCE/TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: To develop accurate analytic models and tools for predicting the damage to surface targets caused by novel warhead concepts.

DESCRIPTION: A need exists for accurate models to predict the effectiveness of novel warhead concepts against the evolving set of threat surface targets such as vehicles, equipment or buildings. Current analytic tools have little or no capability to predict the effect of new or little understood kill mechanisms. Specific kill mechanisms of interest include fire, synergistic effects from focused fragmentation, internal blast and shock against current and next generation threat surface targets.

PHASE I: Quantify the shortcomings of current analytic models as regards new kill mechanisms and next generation targets. Generate new physical and/or semi-empirical models to describe new kill mechanism lethality and target response phenomenon.

PHASE II: Quantify the accuracy of the new performance models by comparing predictions to actual experimental data. Database for new kill mechanisms and next generation targets will have to be developed anew.

PHASE III: Develop computer coding required for performing large-scale performance predictions in an efficient manner. Transition code to industry.

COMMERCIAL POTENTIAL: Internal blast damage prediction models will be applicable to commercial aircraft industry as they endeavor to design bombproof baggage storage compartments. In addition, these blast models can be used to enhance current models used in the design of aboveground and underground buildings which must withstand blast damage. Examples of these structures include office buildings, airports, and residential structures in high risk areas. Firestarting models will be applicable to fire protection and arson reconstruction industries. Finally, the shock models will be applicable for industries which must design equipment to survive shock transmissions.

KEY WORDS: target interaction, lethality, vulnerability, firestarting, internal blast, modeling, shock

N99-033 TITLE: Radiation Hardened Wide Bandgap High Poser High Power DC-DC Converters for Space Applications

SCIENCE/TECHNOLOGY AREA: Electronics

OBJECTIVE: To combine recent research efforts in wide bandgap materials and devices in order to develop DC-DC converters for space-based applications requiring greater than 1kW loads. Radiation tests on the prototype will provide benchmark data on wide bandgap technologies.

DESCRIPTION: Space propulsion, space radar and other power applications require reliable, and efficient DC-DC converters operating at power levels exceeding 1kW. Recently, in the radiation effects field, power devices have shown permanent damage effects due to single ionizing particle radiation. Additionally, technologies utilizing gate and field oxides incur total dose effects due to charge trapping. Recent advances in the wide bandgap materials and devices (GaN, Sic, GaAs, etc) may provide improved efficiency and radiation hardness for power applications in space environments. It is desired that the converter be immune to single event effects such as SEGR, SEB, SEL and total dose levels above 1 Mrad. This work should benefit Navy research programs developing compact power converters with wide bandgap technology.

PHASE I: Formulate initial concepts, propose circuit designs and specify a semiconductor foundry to provide a radiation hard controller for the DC converter. Identify possible suppliers of power devices and confirm radiation hardness of controller IC technology.

PHASE II: Fabricate the controller IC. Provide thorough radiation tests with heavy ions and protons showing immunity. Demonstrate a DC-DC prototype converter utilizing wide bandgap power devices and document a capability to attain at least 1kW operation for PHASE III studies. The prototype should provide improved characteristics over present high-power converters.

PHASE III: Transition the successful hardened prototype to a commercial product. Identify a space platform and formulate a space experiment for the prototype design.

COMMERCIAL POTENTIAL: The need for ion propulsion thrusters requiring in excess of 1kW of power may be common place in the near term. The development of a completely radiation immune DC-DC converter that is efficient would be a very attractive product for the hundreds of planned commercial satellite constellations.

REFERENCES: There is considerable work on DC-DC converter designs in several IEEE journals. Very little documented research exists addressing radiation effects on the wide bandgap materials. Information on radiation effects in power devices such as SEGR, SEB and SEL can be found in the IEEE Transactions on Nuclear Science. For additional documentation, contact TPOC listed below.

KEYWORDS: space power, semiconductors, radiation hardening, Gallium Nitride, Silicon Carbide, power electronics

N99-034 TITLE: Intrinsic Earth Surface Material Classifier

SCIENCE/TECHNOLOGY AREA: Software

OBJECTIVE: Provide a system to process sensor data into permanent earth surface physical descriptor codes from which reliable and accurate sensor signatures can be generated.

DESCRIPTION: The utility of remote sensing measurements are severely limited by the unavailability of a common permanent surface material classification system. This deficiency limits the fusion, comparison, and analysis of measurements taken by different sensor systems, as well as similar sensor systems taken at different times. Classifications in use today tend to be locally calibrated and project-specific. Since spectral signatures generation can be factored into intrinsic permanent material properties and temporary environmental conditions, a system which provides classification and mapping of the permanent component of the earth surface materials is desirable.

PHASE I: Provide an approach and design for the development of a hierarchical classification system of earth surface materials properties pertinent to spectral signature calculations. The approach should: (1) consider abundance and the importance of the materials selected; (2) contain sufficient differentiation of spectral signatures to allow unambiguous classification within the resolution of the classification scheme; (3) provide a table of standard physical properties for each category, and (4) a model for calculating spectral modification due to temporal environmental factors.

PHASE II: Implement a prototype software system which implements the design developed in PHASE I. This PHASE should include the purchase and delivery of a PC based system. The system will utilize sensor spectral and environmental data registered to earth surface locations and provide surface material classification, error probabilities, and a list of likely alternatives. The classification index will be keyed to standard physical properties tables and be capable of generating expected spectral response at other wavelengths and environmental conditions.

PHASE III: The contractor is expected to incorporate the tools developed in PHASE II in order to reduce Ortho-photo, visible, IR, IFSAR, etc., data sources to produce high resolution (1 meter) earth material maps on demand and provide a growing library of surface material classification maps at low (100 meter) resolution. Such data will be provided in standard machine readable formats to facilitate computer utility.

COMMERCIAL POTENTIAL: The availability of intrinsic earth surface material classification systems will support Remote Sensing Data Reduction, GIS Systems, and Earth Resource Repositories. Both the establishment of service bureaus and the direct sales of software tools are envisioned.

REFERENCES: AGlobal Terrain Database Design for Realistic Imaging Sensor simulation, W. Baer, 13th DIS Workshop on Standards for the Interoperability of Distributed Simulations, Vol. I, Sep. 18-22, 1995, Orlando, FL., p. 19.

KEYWORDS: remote sensing; land classification; terrain database generation; spectral signatures; reflectivity modeling.

N99-035 TITLE: Electrohydrodynamic (EHD) Enhancement of Heat Transfer Surfaces

SCIENCE/TECHNOLOGY Area: Science

OBJECTIVE: Investigate the use of electrohydrodynamics for the improvement of heat transfer in liquid/liquid and liquid/air heat exchangers and quantification of potential material weight reduction.

DESCRIPTION: Recent laboratory research has shown that surface heat transfer may be significantly enhanced by the application of electrohydrodynamic (EHD) phenomenon to heat transfer surfaces/heat transfer fluids. EHD works through the application of a high-voltage electrostatic potential field across a heat transfer fluid. The applied electric field serves to destabilize the thermal boundary layer, increasing heat transfer near the heat transfer surface, and producing better mixing of the bulk fluid flow. The net effect is to increase the heat transfer fluid film coefficient, which may result in reduced heat exchanger weight/volume.

Initial EHD laboratory experiments have focused on liquid/liquid heat transfer with the following fluids: refrigerants, including R-123, R-134a, and R-11/Ethanol mixtures, PolyAlphaolenfin, and aviation fuel (JP-8). Although results from these experiments appear promising, the EHD technique required further innovation to address technical obstacles before it will find application. These obstacle include: evaluation of fluids with broader application (e.g. air), development of EHD heat exchanger/electrode design techniques and architectures, potential affect of decomposition of working fluids, research on heat exchanger materials compatible with EHD, and manufacturing process for incorporation of electronics. Additionally, a potential attribute of EHD which has not been explored, but could have military significance is the ability to develop active heat exchangers whose heat transfer capacity can be controlled and modulated. The goal of this project is to solicit innovative approaches that can address current technology deficiencies and result in heat exchanger designs which offer reduced size and weight over the current state-of-the-art technology.

PHASE I: Evaluate the existing AAAV heat exchanger uses and identify candidate applications on the basis of possible weight/size reduction. Investigate combinations of heat transfer fluids, materials, surface geometries, electrode sizes and arrangements, and develop design concept(s). Design concepts shall be supported by models, calculations and published research conducted by the vendor or others. Where needed, basic experiments will be conducted to validate the analytical approach. Additionally, the vendor must address the AAAV operating environment, technology barriers, potential impacts (if any) on material corrosivity and electromagnetic interference, and power conditioning/requirements. Results from PHASE I should clearly point to the best candidate(s) application to be pursued under PHASE II and should predict potential benefits (size, weight, and costs) of the EHD technology to the AAAV program.

PHASE II: Conduct any needed laboratory subscale heat exchanger analysis/experimentation to support EHD heat exchanger development and fabrication. Fabricate prototype(s) and demonstrate the performance characteristics of the EHD heat exchanger through a suitable test stand simulating design thermal loads. Results of PHASE II must clearly demonstrate the performance of the EHD heat exchanger, assess EHD technology maturity and applicability to the AAAV. Additionally, producibility of the EHD heat exchangers must be explored and demonstrated to the greatest extent possible. Potential benefits identified under PHASE I should be readdressed.

PHASE III: The system could be applied to any platform that would benefit from a smaller, lighter weight heat exchanger. Potential customers include the military as well as the aerospace and automotive industries.

COMMERCIAL POTENTIAL: The EHD technique promises high payoff potential for commercial applications such as liquid-cooled avionics, aircraft and automotive environmental control systems, oil and fuel heat exchangers, and potential application in thermal management systems. Industries that may receive immediate benefit from EHD include transportation, aerospace, commercial heat exchanger equipment for refrigeration and air conditioning, electronics cooling, cryogenic and laser medical/industrial cooling.

REFERENCES:

1. Allen, P.H.G., Cooper, P., 1987, "The Potential of Electrically Enhanced Evaporators," Proceedings 3rd International Symposium on Large Scale Applications of Heat Pumps, Oxford, U.K., pp. 221-229.
2. Singh, A., M.M. Ohadi, S. Dessiatoun, M. Salehi, W. Chu, 1995, "In Tube Boiling Enhancement of R134a Utilizing the Electric Field Effect," 4th ASME/JSME Thermal Engineering Joint Conference: Vol. 2, pp. 215-223.
3. Yabe, A., 1992, "Experimental Study of Electro-hydrodynamically (EHD) Enhanced Evaporator for Non-azeotropic Mixtures," ASHRAE Transactions, Vol. 98, Pt. 2, pp.445.
4. M. Salehi, M.M. Ohadi, S. Dessiatoun, 1996, "Minimization of Pressure Drop for EHD-Enhanced In-Tube Boiling of R-134a," Advances in Enhanced Heat/Mass Transfer, Energy Efficiency and Process Heat Integration, Edited by M.M. Ohadi, R. Shekarriz, and S.V. Dessiatoun, ASME, New York, pp. 25-32.
5. Ohadi, M.M., S. Dessiatoun, A. Singh, 1993, "EHD-Enhancement of In-tube Boiling of Alternate refrigerant/Refrigerant Mixtures," DOE Quarterly Report, September 1993, December 1993 and March 1994.
6. Air-Conditioning Research Institute (ARI), "Electrohydrodynamics Heat Transfer," Research and Technology News Update, January 1996.
7. Conversations with Dr. Michael Ohadi, Group Leader for Heat/Mass Transfer Applications, Center for Environmental Energy Engineering, University of Maryland.

KEY WORDS: heat transfer, heat exchangers, electrohydrodynamics

N99-036 TITLE: Non-GPS Navigation Accuracy Improvement for Land and Water

SCIENCE/TECHNOLOGY AREA: Ground and Sea Vehicles

OBJECTIVE: To devise a system to determine position in land and water navigation with an accuracy of better than 1% of distance traveled without using GPS or radar. Low weight, size and cost are also an objective.

DESCRIPTION: GPS is the most accurate navigational means available, but it is also vulnerable to jamming and shadowing. Without GPS, Inertial Navigation is the next most accurate stand-alone system. The effectiveness of Inertial Navigation Systems diminishes in water travel due to currents and drifts.

PHASE I: Devise a system to measure position in land and water without GPS or Radar to an accuracy of less than 1% of distance traveled. The system should use a sensor or combination of sensors that would reduce the vulnerability to jamming and the effects of currents and drifts. Demonstrate the feasibility to do this in a device that is small, lightweight, and affordable and calculate the expected accuracy and reliability. Demonstrate a prototype devise under laboratory conditions and document the results.

PHASE II: Build and test a prototype model, present the test results, including the accuracy achieved. State what effort will be required to decrease the size and weight and increase reliability in production. Estimate the unit cost for expected quantities in production.

PHASE III: Package the device into a modular system that could easily be installed on civilian and military vehicles.

COMMERCIAL POTENTIAL: The commercial potential for this system will be in all aspects of marine navigation, commercial, pleasure, and military.

KEY WORDS: navigation; marine; modular; small; light

N99-037 TITLE: MARINE COLLISION AVOIDANCE DEVICE

OBJECTIVE: To devise a system which will detect water subsurface obstacles at depths of 20 feet or less, while operating in a marine environment.

DESCRIPTION: At a speed of 25 nmph, a surface craft needs light weight, physically small size detection device which will provide warning in sufficient time for the driver to react.

PHASE I: Devise a concept to detect water surface and subsurface obstacles at depths of 20 feet or less, while operating in a marine environment with minimal signal emission. Demonstrate the feasibility to do this in a device that is small, lightweight, and affordable and calculate the expected reliability. Determine the range that the device can accurately detect obstacles, and the distance the emissions can be detected by an outside detector. Demonstrate a prototype devise under laboratory conditions and document the results.

PHASE II: Build and test a full scale prototype and present the test results, including the distance and accuracy achieved. State what effort will be required to decrease the size and weight, increase reliability and range in production. Estimate the unit cost for expected quantities in production.

PHASE III: Package the device into a modular system that could easily be installed on civilian and military vehicles.

COMMERCIAL POTENTIAL: The commercial potential for this system will be in aspects of marine navigation; commercial, pleasure, military, and amphibious.

KEY WORDS: navigation, marine, collision avoidance, small, light

N99-038 TITLE: Roll Safety Improvements for Narrow Track Vehicles

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

OBJECTIVE: The objective of this effort is to develop innovative methods and hardware solutions to mitigate roll over tendencies of V-22 Tiltrotor internally transportable light tactical vehicles during high g-force maneuvers.

DESCRIPTION: The MV-22 Tiltrotor aircraft is the Marine Corps medium lift replacement for the CH-46 and will be used to transport lightweight, highly maneuverable four wheel drive vehicles. These vehicles, which typically have high ground clearance and therefore center of gravity for off road mobility, must have a width less than 68” to facilitate entry into the cargo area. This combination of high c.g. and narrow track width, combined with unpredictable off-road terrain and aggressive driving under combat conditions, can lead to the increased probability of vehicle roll incidents. Recent government testing and safety certification of the Helo Transportable Tactical Vehicle (HTTV) at the Aberdeen Test Center (ATC) has verified this problem. This effort will research and develop a quick response active roll control system using body roll sensors linked to the suspension system to shift the vehicle c.g. as necessary (e.g. sudden lane change maneuver) to avoid vehicle roll over.

PHASE I: Utilizing the government owned HTTV as a baseline vehicle, investigate technologies, devices, and control systems and algorithms necessary to limit the body roll angle to less than 5 degrees during a .6g maneuver. Calculation and prediction of performance improvements should be made. Perform conceptual design studies followed by preliminary hardware designs and the generation of control software strategy. Identify any new components and/or modifications to existing vehicle components necessary to integrate the system to the HTTV. Generate a test plan and procedures to qualify the system on an HTTV at ATC during Phase II.

PHASE II: Perform system and component detailed design and generate control system software code as necessary. Fabricate all necessary new components and modify existing vehicle suspension components. Integrate roll control system onto vehicle. Refine vehicle test plan and perform tests at ATC to certify the performance and safety of the vehicle. Generate final report.

PHASE III: Transition roll control systems to the Marine Corps' Light Strike Vehicle and Internally Transportable-Light Tactical Vehicle programs.

COMMERCIAL POTENTIAL: This system could be used to increase the safety of sport utility vehicles that are prone to roll problems during sudden lane change maneuvers.

REFERENCES: RST-V Home Page: http//www.usmc-awt.brtrc.com/rst-v/rstv.htm

KEY WORDS: Mobility; steering, roll control, active, suspension, stability

N99-039 TITLE: Lightweight Armor Solution

SCIENCE/TECHNOLOGY AREA: Materials / Manufacturing Science

OBJECTIVE: Design an armor solution for application to the AAAV (Advanced Amphibious Assault Vehicle) with a density of less than 17 lb/ft^2.

DESCRIPTION: Weight is critical to the success of the AAAV program. Armor is a major contributor to the overall weight of the vehicle and is a prime candidate for weight reduction initiatives. An armor system of less than 17 lbs/ft^2 may be viable. A lighter weight armor solution for the vehicle could potentially result in as much as a 1000 lbs. savings. The weight savings could also be applied to increasing the combat effectiveness of the system. The contractor must possess a secrete clearance prior to award of this SBIR.

PHASE I: Develop and build solutions for an armor system which is less than 17 lb/ft^2 that meets the AAAV Armor Specification requirements to defeat a 14.5mm threat at 300 meters and a 155mm artillery bursts at 50 ft. The resultant armor design must posses the capability of being readily integrated into the modular armor concept of the vehicle. The vender must demonstrate that the design meets the requirements though laboratory tests or simulations.

PHASE II: Produce prototype armor and support government ballistic testing. Develop a manufacturing scheme to mass-produce the armor, capable of outfitting the AAAV in full-scale production.

PHASE III: Investigate the use of the armor solution on vehicles expected to endure explosive environments. (security vehicles, armored diplomat carriers, etc…)

COMMERCIAL POTENTIAL: Potential in lighter weight armor solutions for security vehicle where weight and armor protection is a concern. Any light armored vehicle expected to be in an explosive environment (fire fighting vehicles, protection of vulnerable equipment on oil rigs, etc…)

REFERENCE: AAAV Armor Specification, classified at the secrete level.

KEY WORDS: Lightweight, Armor, Advance Amphibious Assault Vehicle (AAAV),

N99-040 TITLE: Expedient Foam Technologies for Marine Corps Operations

SCIENCE/TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Demonstrate the capability and affordability of rigid polyurethane foams (RPF) as an expedient construction material to improve the operational capability of Marine Corps units conducting expeditionary operations.

DESCRIPTION: This project will develop and test a deployable rigid polyurethane foam dispensing unit to use in field demonstrations of foamed facilities to support Marine Corps expeditionary operations. Demonstrations of field applications of RPF will include, but are not limited to, a gap crossing, barrier material, channeling material, stabilized beach and marsh roadways for tactical and cargo handling equipment. Ongoing research on RPF material properties will be tailored toward Marine Corps expeditionary applications. The demonstrations will show the utility as well as the affordability of RPF as a construction material for Marine Corps expeditionary operations. The project will develop techniques and hardware required to demonstrate the capability to use RPF as a superior material for use in the expeditionary environment. Scientific work performed to date indicates that RPF foam has extraordinary material properties that make it highly suitable for expeditionary applications. To use RPF to solve existing shortfalls in expeditionary logistics operations requires taking the technology to the next level. The ability to use rigid polyurethane foam (RPF) effectively in expeditionary logistics operations applications requires new methods of dispensing large quantities rapidly, formulating the optimum foam for the expeditionary environment, and structural design concepts to take advantage of the foam's properties.

PHASE I: Determine the engineering issues in the foam selection process; select physical properties (density and strength) of RFP required for expeditionary applications; evaluate combining foam with sand or other abundant local material to add mass if needed; determine if foam should be closed cell or if open cell foams work best for the selected applications. Conduct small scale demonstration for dispensing foam in an expeditionary environment with minimal footprint.

PHASE II: The capability to mix and pour large amounts of RPF in a short time is critical. With existing foam mixing techniques, it would take about five hours to mix and pour the volume of foam equivalent to a 90'x21'x5' pad. Critical engineering issues in mixing and moving RPF include: develop the equipment required to mix and move the foam rapidly into forms; investigate mixing the two foam constituents in place to eliminate pumps and piping; develop methods to dissipate the heat generated by the curing foam. State of the art methods may be scalable to achieve desired mixing goals. The other critical issue to resolve is the RPF formulation that will be most effective for both the expeditionary and beach environments. The usefulness of the foam is in the simplicity of formulation and application, as well as its physical properties. The constituents of the foam must be examined to select properties for the expeditionary applications. Develop a large volume RPF dispensing unit and foam constituents suitable for field use by expeditionary forces.

PHASE III: Commercial availability of materials and dispensing systems.

COMMERCIAL POTENTIAL: This type of equipment for placing large amounts of foam could be use in any area that uses significant amounts of RPF. An example would be in installing RPF as a building insulation.

REFERENCES:

1. Sandia Laboratories has been involved in development of RPF technology for several years under an memorandum of understanding between the department of energy and the department of defense (Office of Munitions). Sandia’s work is monitored by a steering committee, which has representatives from the Navy, the USMC, the Navy’s shore technical community. The US Army is expected to be represented this year. Sandia is funded over the next two years to complete tasks associated with obstacle and mine field breaching. Some of the tasks scheduled for the next two years complement the work of this proposal.
2. Benning, Calvin J., Plastic Foams: The Physics and Chemistry of Product Performance and Process Technology, Volume II, Structure Properties and Applications.
3. Modern Plastics, Mid October Issue.
4. Roark, Raymond J., Formulas for Stress and Strain, McGraw-Hill Book Company.

KEY WORDS: Foam; urethane; polyurethane; construction

N99-041 TITLE: Urban Mobility Planning and Awareness Tool

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

OBJECTIVE: To provide Marine Corps strategists the ability to plan for, and operate within, urban environments in support of both wartime and humanitarian objectives.

DESCRIPTION: It has been anticipated that future military operations will occur in the urban areas of the world’s littoral environment. The mobility of troops and equipment through the strict confines and unique barriers of an urban environment presents new challenges to the strategists responsible for planning for operations in this environment. The quick response time required to meet these operations preclude advanced planning, preparations, and installation of mission and geographic specific equipment onto vehicles used for such missions. Vehicle operators need mission planning tools and mobility awareness tools to assist drivers and commanders in conducting operations. This effort will use all available information regarding urban area topology and general characteristics to provide advanced planning, in situ awareness, and near real time reports on obstacles that are likely to be encountered during urban operations. This Driver’s Information and Direction Panel (DIDP) will provide navigational and awareness information via maps generated from scanned-in images downloaded to the vehicle DIDP and developed while onboard ship or in transit to the area of operation. The urban terrain data can be used as a planning tool for operators and as a mission awareness report for location and reporting of terrain features (e.g., "streets are generally xx inches narrow", "street types are 20% clay, 10% paved, 60% unimproved", or "80% of the buildings are less than 3 stories tall").

PHASE I: Develop concepts, perform trade-off analysis, and design a Drivers Information and Direction Panel (DIDP) to be used as a common add-on system aboard various USMC vehicles (e.g., AAV, LAV, Tanks, HMMWV, LVS, MTVR, AAAV, SURC, etc.). The DIDP shall include non-magnetic compass, heading indicator, steer-to indicator, way point settings, secondary indicator for relative pointing of turret in relation to hull, differential GPS, low-cost stored map display synced to GPS to show position on terrain, and a back-up system for position and sync to map when GPS signal is lost. The DIDP will be required to operate in both watercraft and land vehicles and must fit within 50 square inches by 3 inches deep for display device and less than 400 cubic inches for storage, processing, and sensor systems. Design goals will be to meet an estimated AURP of less than $1,000 for a production quantity of 10,000 units and extensive use of COTS items (e.g., PCs, mass storage, flat panel displays, scanners, satellite navigation systems for high end automobiles, etc.). Part of the Phase I effort will be to perform trade-off analyses by applying weights and ranking the merits of each functional element to meet the Design-to-Unit Cost goal.

PHASE II: Develop, demonstrate and test a breadboard DIDP unit that has all the features and functional characteristics required to operate in urban environments aboard USMC vehicles.

PHASE III: Based on a successful Phase II effort, develop a prototype model for qualification, test and evaluation, and production purposes, including any required supporting software and documentation, for a Driver Information and Direction Panel unit which will be integrated into an existing USMC vehicle.

COMMERCIAL POTENTIAL: This system could be used by a host of commercial and governmental organizations required to operate within urban environments such as emergency police, medical, and rescue equipment; commercial trucking and distribution companies; civilian traffic reporting and correction; security firms; etc. In addition, this new technology supports the US Department of Transportation's "Intelligent Transportation System" to better regulate and insure safe transit within urban infrastructures.

REFERENCES:
1. Military Operations in Urban Terrain: http://138.156.112.14
2. Actual accounts of operations during Mogadishu, Somalia: http://www3.phillynews.com/packages/somalia
3. Intelligent Transportation System: http://www.its.fhwa.dot.gov

KEY WORDS: Mobility; obstacles; analysis; transportation; urban

N99-042 TITLE: Composite Components for the Advanced Amphibious Assault Vehicle (AAAV)

OBJECTIVE: The AAAV program office is interested in replacing some of the aluminum and Steel components in the track and suspension, hull and interior of the vehicle to reduce weight.

DESCRIPTION: Previous attempts to implement composites have run into problems because of the harsh operating environment of the AAAV. The vehicle will operate in sea water, in sand and mud and in dense vegetation. New techniques for laying up composites may allow replacement of components that are currently made of metal while reducing weight and maintaining reliability/durability.

PHASE I: Review the current design of the AAAV to determine where composite technology could be employed to reduce the weight of components by at least 30%. Develop a list of potential candidates and determine what manufacturing processes would be employed to produce the parts. Prepare a report to document the findings including estimates of life cycle cost, reliability and weight savings. Demonstrate the performance of the composites in a laboratory environment and document the results.

PHASE II: Build and test selected parts to prove they meet the requirements of the AAAV. Produce prototypes for government testing. Evaluate the results of the government testing and make recommendations concerning the suitability of the composites for the AAAV.

PHASE III: Market composite technology developed under this SBIR to other armored vehicle programs. Modify/scale components for commercial applications to include automotive, commercial watercraft and pleasure boats.

COMMERCIAL POTENTIAL: The commercial potential for the resulting technology from this SBIR is unlimited. Composite parts in automobiles, trucks, rail cars, shipping and pleasure craft would increase fuel efficiency, reduce damage caused by corrosion and reduce pollution.

KEY WORDS: composites, lightweight, harsh environment

N99-043 TITLE: Lightweight Overpressure Containment Ammunition Box

SCIENCE/TECHNOLOGY AREA: Materials, Processes, and Structures

OBJECTIVE: To design lightweight armored ready and stowed ammunition boxes that contain and prevent leakage of propellant gases into a combat vehicle crew space after an overmatching threat. The boxes must provide additional protection from medium level threats and mitigate the effects of higher level threats.

DESCRIPTION: Protection of ammunition within combat vehicles is important to reducing the vulnerability of the system. A ready ammunition box and feed system which contains the overpressure and toxic gases generated due to the effects of overmatching threats is required. A similar concept is needed for stowed ammunition. Both concepts must provide mechanisms for venting the gases to the exterior of the vehicle.

PHASE I: Develop and provide a design for these ammunition boxes which protect, contain and vent exterior to the vehicle overpressure gases generated by ammunition ignition by an overmatching threat. The design must meet the operational requirements of the AAAV Fire Power components. The vendor will be required to demonstrate through mathematical calculations and modeling that the design meets the above requirements. The boxes shall be designed so they can be integrated into the vehicle as modular units.

PHASE II: Produce prototype boxes and support government ballistic testing using potential overmatching threats along typical vehicle shot lines. Develop a manufacturing scheme to mass-produce the armor, capable of outfitting the AAAV in full-scale production.

PHASE III: Investigate potential of design to be implemented in the containment and shipment of volatile materials.

REFERENCE: AAAV ammunition box interface drawings. Non-Disclosure agreement with General Dynamics is required to obtain these drawings.

COMMERCIAL POTENTIAL: The design and design concepts could be used in luggage carrying boxes in airplanes to protect against terrorist attack. These concepts could also be used in shipping volatile materials, such as explosives, from destroying the carrier in case of an accident.

NAVAL AVIATION TEAM

N99-044 TITLE: Oxygen System Trickle Charger

SCIENCE/TECHNOLOGY AREA: Materials; Human-System Interfaces

OBJECTIVE: To develop an aircraft oxygen generator for trickle-charging high-pressure gaseous oxygen supplies.

DESCRIPTION: Many military and commercial aircraft use high-pressure gaseous oxygen cylinders to supply the aircrew with oxygen during emergency operations. These systems require periodic inspection, testing, and servicing. An airframe-mounted oxygen-generating system is needed to replenish the system after testing, preflighting, and routine leakage. The system must be able to generate 2 to 4 ambient liters per minute of 99.9-percent pure oxygen. The operating altitude is sea level to 50,000 feet. The oxygen must then be pressurized to 2500 psig for storage. The system must use electrical power only (i.e., no source of compressed air is available). The system must be intrinsically safe (low operating temperature) with minimal moving parts. The system must also have an immediate startup capability at room temperature.

PHASE I: Focus is on the materials research required to produce the required oxygen. Perform trade studies to assess the state of the art in advanced materials for electrochemical oxygen production. Provide a conceptual design for an aircraft oxygen system trickle charger. The design will include system performance assessment, with consideration for aircraft altitude and temperature. The design should include material selection, geometry, size, weight, failure modes and effects, startup characteristics, and safety. The design should be supported by laboratory data and a working bench-top model to validate the oxygen generation performance at ground level to a pressure of 15 psig. The design should also include a strategy for meeting the 2500-psig requirement.

PHASE II: Develop and demonstrate an oxygen system trickle charger for a multipassenger (Navy, USAF, or commercial) aircraft. Optimize the design, develop special tools or tooling, generate tooling using state-of-the-art CAD/CAM techniques, optimize components, and produce laboratory and prototype flight test hardware. This phase will also include qualification test planning, life-cycle cost estimating, cost estimating for full production, and reliability and maintainability assessment.

PHASE III: Optimize aircraft integration. Produce the oxygen system trickle charger demonstrated in Phase II.

COMMERCIAL POTENTIAL: Commercial airlines and medical facilities use high-pressure gaseous systems and will benefit from this effort. This proposal requires advance development, with direct application to the $10 billion commercial market for oxygen equipment.

REFERENCES:
1) AFGS-87226A, USAF Guide Specification for Oxygen Systems.
2) JSCG-1776-11, Joint Service Guide Specification for Oxygen Systems.

N99-045 TITLE: Cost Estimation Model for Aircraft Weapons Integration

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop a model for predicting aircraft integration and certification cost.

DESCRIPTION: Historically, aircraft integration and certification are major cost and schedule drivers for new aircraft acquisition programs, as well as system upgrades. It is envisioned that such a model would be utilized for predicting cost and schedule requirements throughout the life cycle of an aircraft program. Another purpose of this cost model would be to evaluate cost benefits of new tools and technology applicable to this technology area. The model must be able to predict the certification and integration cost of weapons on a new tactical aircraft, as well as on new weapons on existing platforms or system upgrades.

PHASE I: Conduct a detailed study of the types of cost models that could be developed to predict aircraft integration and certification cost. The study must indicate what parameters would be tracked and what cost methodologies are being employed.

PHASE II: Based on study results obtained from Phase I, develop and demonstrate a cost model which predicts aircraft integration and certification cost. A method or recommendations must also detail how such a model would be validated.

PHASE III: The availability and demonstration of an accurate model to predict cost and schedule requirements for aircraft integration and certification will have a significant payoff for commercial and military applications. Major aircraft acquisition programs have limited capabilities to determine out-year funding and for the Government to better plan and manage its resources in this area. An added benefit of this model is the identification of the potential payoff of new engineering tools and technologies being inserted into the process to reduce cost and schedule requirements. This will assist in determining the technology.

REFERENCES: MIL-HDBK-1763 and NAVAIR INST 13100.14

N99-046 TITLE: Innovative Methods for Incorporating Lightning Protection in the Applique Technology

SCIENCE/TECHNOLOGY AREA: Materials, Processes, and Structures

OBJECTIVE: To develop a technology which can be incorporated in the applique to meet the lightning protection requirement for composite structures. The technology shall meet the performance requirements of MIL-STD-464.

DESCRIPTION: For Naval aircraft systems, subsystems and components are typically designed so that there is no loss of life or vehicle from severe lightning attachment with a 200-kiloamps first-return stroke having a peak rise time of 1.4×10^{11} amps/sec to the aircraft. In addition, naval aircraft systems are designed so that there are no personal injuries and/or endangered mission success from a lightning attachment with a 50-kiloamps first return with peak rise time of 3.5×10^{10} amps/sec to the aircraft. The naval aircraft is designed with the capability of being restored to its original lightning protection after the repair or replacement of systems, subsystems, or components due to wear, tear, corrosion, or damage-8,2,B.Composite structures are being designed with copper mesh on the exterior surface to meet the lightning protection requirements for aircraft design. Currently, there is no approved technology which can depaint without damaging the copper mesh. In addition, repair procedures performed on these composite structures are more difficult and costly. The applique technology is being developed to replace the topcoat on aircraft. Having the lightning protection integrated in the applique will result in less difficult and costly repair procedures for composite structures.

PHASE I: Develop lightning strike materials technology to incorporate into the applique. This technology shall meet the performance requirements of MIL-STD-464 when placed on the composite structure. Conduct preliminary laboratory testing to demonstrate the feasibility of this technology for composite structure lightning protection.

PHASE II: Further develop the technology to meet the objectives of Phase I results. The contractor shall conduct both laboratory testing and field testing. The above testing shall demonstrate that this technology meets all the performance requirements of MIL-STD-464 for composite structures. If necessary, propose an amendment to the existing Government or commercial specification or propose a new Government or commercial specification to cover this new technology.

PHASE III: Produce the applique with the technology demonstrated in the Phase II effort for both the military and commercial market. If further development and/or field testing is required, aircraft program funding will be pursued.

COMMERCIAL POTENTIAL: An applique with lightning protection capability can be used on commercial aircraft. Therefore, this technology is directly transferable.

REFERENCES: MIL-STD-464

N99-047 TITLE: Crew Centered Armament System for High Technology Cockpit

SCIENCE/TECHNOLOGY AREA: Human-System Interfaces

OBJECTIVE: Develop a Crew Centered Armament System capable of performing Air-to-Air and Air-to-Ground missions using onboard and offboard data through a helmet-mounted display to acquire targets and independently target internally and externally carried weapons.

DESCRIPTION: Modern technology has lead to an explosion in available information emanating from varied sources. Applicable technologies are emerging to deal with information collection, information transmission, information processing, and information display. Properly managed this information can yield: (1) higher probability of kill per weapon launch over conventional aircraft methods, (2) increased target kills per aircraft sortie and (3) capability for mission planning/re-planning enroute. The emergence of Asmart weapons has added complexity with the benefit of flexibility to this complicated issue. Weapon suspension & release equipment will need to manage information flow between weapon and aircraft for target acquisition and independent targeting. The operational requirement to be stealthy, as on the JSF, will revolutionize the method of mission execution and proper information management is the key to meeting the objective. It is anticipated that the Heads-up Display will be replaced with a Helmet-mounted Display (HMD). The best use of HMD has been demonstrated to be the air-to-air mission but the need exists to accommodate the air-to-ground mission. Synthesizing onboard and offboard data to a pilot manageable level needs to deal with varying data: accuracies, timing, range, scale and priorities. The desired system is to create a highly effective crew friendly armament system with high-leverage force multiplication, multiple kills per pass, significantly reduced logistics and high-degree of interoperability across a variety of aircraft. Innovative technologies will be applied in helmet-mounted displays, sensor fusion, information management, human factors and weapon suspension & release equipment. Pilot workload and mission effectiveness enhancement will be considered throughout requirements development. The Awindows of opportunity for integration of these technologies in-part or whole into aircraft block upgrades or developments will be identified as part of the initial feasibility study. Cost per kill and total cost of ownership will be critical metrics for the overall system. Novel and innovative low cost design, manufacturing and supportability concepts will be explored. A Life Cycle Cost (LCC) model will be developed to assess design alternatives and system concepts will be developed, prototyped and demonstrated under this effort.

PHASE I: Provide a final design concept to be demonstrated during Phase II. Conduct a feasibility study to identify candidate aircraft based on operational missions through 2025, and based on the cost and feasibility of aircraft integration during this time frame. Given HMD based armament system technology enhancements identify specific mission tactics for each selected aircraft. Develop system safety/performance requirements and evaluate crew centered armament system design concept alternatives for the selected aircraft. Down select to one concept and identify resultant improvements to the Naval aviation tactical mission emanating from the proposed design concept.

PHASE II: Design, fabricate, demonstrate and evaluate the proposed system. Conduct man-in-the-loop studies to assess pilot workload and survey pilot opinions. Conduct system simulations and performance tests to assess compatibility/effectiveness in Naval operational and mission environments.

PHASE III: Produce four (4) flight suitable ship-sets. Conduct flight trials to validate system effectiveness and measure performance under dynamic conditions.

COMMERCIAL POTENTIAL: This system has high potential in commercial applications. The aircraft prime contractors of the selected aircraft, crew system equipment developers, weapons developers and foreign military all have high potential as customers of the resulting products. The system will also have the potential for non-military applications where data management and control of electro-mechanical systems is required in a demanding industrial environment. A commercialization study will reveal specific applications for technology transfer.

KEY WORDS: Human-Systems Interface; Air Warfare; Command, Control, Communications, and Computers; Precision Attack; Aircraft Systems; Weapons

N99-048 TITLE: Gas Turbine Hot Section Parts Innovative NDI Systems Research

SCIENCE/TECHNOLOGY AREA: Aircraft Propulsion and Power

OBJECTIVE: Investigate innovative NDI systems, equipment and methodologies to reduce cost of ownership for the DOD gas turbine engine user. Investigate Non-Destructive Inspection NDI techniques capable of repetitively, accurately and economically determining thermally-selective conditions & defects. Examples of such defects include, but are not limited to, the qualitative or quantitative heat transfer effectiveness of cooled blades, bonding quality defect visualization, or cooling hole condition status. The aim of the NDI system will to able to assess suitability for initial or continued engine service of turbine hot section parts, such as combustors, turbine (vanes and blades), and exhaust nozzle parts and assemblies, based upon thermally sensitive characteristics and trends and projected performance variations. Method(s) useful in both pre- & post-assembly and in-situ (non-operational) engines to assess component thermal-resistance and predict qualitatively or quantitatively structural capacity for continued service should be investigated.

DESCRIPTION: Gas turbine hot section engine parts may be assessed for life limiting conditions and/or predictive trends during the manufacturing process and on into field usage. The goal of this effort is to assess the feasibility of detecting and trending governing thermal characteristics of hot section components. For example, trending of blade cooling effectiveness variations and/or growth of thermally indicated structural flaws. In cooperation with a major aircraft turbine engine manufacturer, investiaget and assess the feasibility of an NDI system(s) which is affordable, reliable, with situationally adaptable configurations / user interfaces to evaluate life governing thermal characteristics of current and advanced cooled hot section parts using techniques such as, but not limited to, stimulated gradient IR imaging, semi-quantitative automated image analysis and statistical trend analysis.

PHASE I: Identify types of defects and assess the feasibility potential of a standardized prototype inspection system (hardware, software and support equipment) to semi-qualitatively measure life governing characteristics of to-be-determined regions on combustor, turbine and exhaust air-cooled hardware. Investigate the pre- & post-assembly and engine in-situ inspection system interface configurations & potentail hardware specifications. Define user interface requirements for the technician and, Level I to Level III inspectors for selected defect types. Project the potential cost savings to DOD upon using such new capabilities (e.g., minimize unscheduled engine removals (UERs) and shutdowns). Define applicability to new, reworded, and in-service hot section components.

PHASE II: Develop and demonstrate an NDI system (hardware and software) capable of effectively measuring parameters of interest, such as, heat transfer effectiveness, bonding quality, wall thickness. Further demonstrate in-situ engine inspection configuration accessibility upon applying new NDI systems to detect defect features, such as on full blade surface cooling hole condition assessment. Show tracibility of inspection result trends from new to used combustor, turbine and exhaust nozzle parts and other subassemblies. Re-evaluate the potential cost savings to DOD. Look also beyond airplatform applications exclusively. Further rigorously evaluate potential cost savings of utilizing capability at the engine manufacturer and at overhaul facilities. Develop mature designs for eventual transition into engine production processing & DOD fleet operations.

PHASE III: Commercialized inspection systems and introduce into the marketplace.

COMMERCIAL POTENTIAL: Accurate and economical inspection of complicated air-cooled gas turbine hot section parts is as important to the US commercial aircraft market as it is to the DOD. For example, the commercial gas turbine industry would benefit from the reduction of inspection costs and unscheduled removals as well. Both commercial and military users will also save maintenance costs by not scraping costly hot section parts that are actually flight worthy and acceptable for additional use. As well marginally perfroming parts will be identified earlier in their life and culled out thus avoiding unscheduled costs.

KEY WORDS: Non-destructive, inspection, non-destructive test, gas turbine, air cooled, hot section, NDI, NDT

N99-049 TITLE: Heating System for Curing Composite Repairs on Complex-Shaped Structures

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: To develop low-cost, easy-to-use heating systems that can cure composite repairs on complex shaped aircraft structures in a Navy field-level environment.

DESCRIPTION: Standard heat blankets have fixed shapes, such as circular or rectangular, and limited conformability. The repairs to be addressed here will involve curing on double-curved shapes, such as a nose cone, around squared 901 corners, and in areas with multiple frames. To meet these requirements, the system will need to be very flexible in shape and size. The system needs to maintain even temperature distribution ("10 1F) across a repair area of 330 square inches and account for heat sinks due to fasteners and frames. Two cure temperature ranges to be addressed are ambient to 400 1F for most epoxies and ambient to 775 1F for high-temperature composites. Ambient field environmental temperatures can range from 40 to 120 1F. System heat-up rates should range from 1 to 9 1F/minute. Temperatures and heating rates need to be adjustable by 1 1F, and dwell times need to be adjustable by 1 minute. The controller should be capable of inputting an unlimited number of temperature rises and soaks for a particular cure. The user interface of the controller and operation of the heating system shall be understandable at an eighth grade reading level. The controller should also be able to incorporate and control additional heat zones for large repairs. The design of this heating system needs to address the safety requirements for applying heat to operational aircraft.

PHASE I: Evaluate and develop prototype designs for a new heat curing system. Perform market search for commercial and military applications that require cures on complex-shaped structures.

PHASE II: Develop, design, and build field-portable prototype heat curing systems based on the information gathered in Phase I. Field-test these prototypes at Navy, DOD, and commercial composite repair facilities. Market this concept prototype in the military and commercial industry.

PHASE III: Design and develop a commercial production line of the new heating system based on learning experiences from Phase II. Field-test this product line at Navy carrier and field repair facilities to meet the needs of current and emerging aircraft programs, such as the V-22 and F/A-18E/F. Field test this product line at other DOD and commercial composite repair facilities. Market this production line in the military and commercial industry.

COMMERCIAL POTENTIAL: Military and commercial composite repair facilities have been troubled with performing repairs on complex-shaped structures. Often, room-temperature curing systems are used, which have poor mechanical properties and require significant downtime for curing. Hot air guns and heat lamps often use the same materials at a faster rate, but use of these devices is limited due to poor temperature control and safety concerns on operational aircraft. The development of a new heating system under this topic will allow the use of structural repair materials requiring elevated temperature cures and significantly reduce downtime for the repair.

KEY WORDS: Composite Repair

N99-050 TITLE: Advanced Methods for Detection of Aircraft Corrosion Under Paint and Appliques

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: Aircraft corrosion can often be mitigated through repair and repainting if the corrosion is located before significant damage occurs. The sensitivity of corrosion detection under aircraft paint and appliques needs to be at sensitivity levels sufficient for early repair or monitoring alerts. Corrosion onset is often very localized and sparse, and the objective of this topic is to develop highly sensitive methods for early detection of corrosion hidden by aircraft paint and appliques.

DESCRIPTION: Current aircraft corrosion nondestructive evaluation (NDE) methods include guided wave ultrasonics, eddy currents, and many other NDE approaches. Few, if any, of these are sensitive enough to detect the earliest stages of the onset of corrosion. There may be some advantage to be gained by modifying the paint or applique to enhance the sensitivity of corrosion detection. Synergistic modification of paints and appliques, coupled with a given NDE technique, should enhance corrosion sensitivity. Paint/applique modifications must be compliant with existing military standards for coatings. A measurable improvement of corrosion detection sensitivity must be demonstrated and quantified, and proposals should address how this improvement will be accomplished in Phase I. Techniques for improving current methods through imaging or data processing are not sought B proposed methods should include innovative sensor/coating interactions that can be exploited to improve corrosion detection sensitivity. This technology would apply to airframe skins including both aircraft and missile structures. The sensor should be able to detect up to 10 ppm Cl and between 2 and 5% moisture content.

PHASE I: Demonstrate, at laboratory specimen scale, the ability to enhance NDE sensitivity to corrosion using a combination of modified paint and optimized sensor designs. It is important to demonstrate the sensitivity advantage provided by the approach over alternate methods. Determine the level of operator training required in practice for aircraft inspection. Systems with minimal training and expertise are preferred. System cost is also an important consideration, and an inspection cost model for an aircraft should be developed for use in Phase II.

PHASE II: Develop an NDE product prototype based on the combination of an engineered paint or applique and sensor technology. Demonstrate that the paint/sensor approach satisfies environmental considerations and is capable of detecting the onset of corrosion in aircraft structures. Phase II tests should include large structures, which show the potential for aircraft inspection. Inspection costs should be estimated for an entire aircraft based on the inspection rates achieved in Phase II testing, training requirements, and operational downtime.

PHASE III: Develop transition plans for the manufacture of proven product (an NDE tool for inspection of corrosion under Applique`) through an industrial partner. If possible submit a proposal for Manaufacturing Technology Program for support.

COMMERCIAL POTENTIAL: A primary commercial target is the airlines, with a secondary target in air transport. As commercial aircraft age, the need for cost-effective and rapid corrosion inspection increases.

KEY WORDS: Under Paint Corrosion; Detection Method; Sensors; NDE; Applique; Aircraft System

N99-051 TITLE: Multipurpose Mobility Platform (MP)2

SCIENCE/TECHNOLOGY AREA: Human/Machine Systems Integration

OBJECTIVE: To develop an inexpensive generic, modular, heavy-lift, stable, reconfigurable, ergonomic omnidirectional electrically powered mobility platform for use in support of Navy and Marine Corps sea-based aviation.

DESCRIPTION: One of the most important elements contributing to the effectiveness and efficiency of Navy and Marine Corps sea-based aviation support systems is the movement of aircraft components, munitions, and other aviation support materiel on the flight deck, hangar deck, and throughout other spaces on the ship. On a typical large deck aircraft carrier, this function consumes many thousands of labor hours, ties up hundreds of personnel, and has hundreds of equipment items dedicated for this purpose.

As naval aviation prepares to enter the 21st century at the center of the nation's defense establishment, two important requirements are emerging that are demanding major changes in the way the Navy operates aircraft at sea. The first of these emerging requirements is the need to reduce the cost of conducting sea-based tactical aviation operations. Two effective ways of achieving this are by reducing the number of personnel required to perform aviation support operations and by reducing the proliferation of aviation support equipment. One effective method of reducing personnel is to reduce workload requirements through technology insertion. Support equipment proliferation can be reduced by reducing both the aggregate quantity and the different types of support equipment needed to support air operations. Technology insertion can also have a major impact on support equipment proliferation.

The second emerging requirement is the need to increase the number of combat missions performed by each aircraft in the sea-based airwing over a given period of time. This is called increasing sortie rates. This requirement has emerged because the Navy will be operating fewer, but more capable, aircraft than it has in the past. To maintain the same level of combat effectiveness, there is a need to generate more sorties. In order to support higher sortie rates, the shipboard aircraft support system must also operate at a higher operational tempo. This means that aircraft turnaround times (TAT) and aircraft support cycle times must be reduced. Thus, material must be moved throughout the ship faster and more efficiently.

To facilitate reductions in personnel workload, to reduce the aggregate number and different types of aviation support equipment needed to transport and handle aviation support material, and to help reduce aircraft support cycle times, a multipurpose mobility platform (MP)2 is needed. The (MP)2 shall be an inexpensive, generic, highly maneuverable, electrically powered mobility platform on which various functional modules can be readily removed and replaced. The (MP)2 shall be omnidirectional to maximize mobility through deck clutter and to contribute to reduced personnel workload. The (MP)2 shall be designed using modular components that will allow it to be readily reconfigured for different applications. The basic mobility platform will be the foundation for future multiple shipboard aviation support applications.

PHASE I: Develop concepts and optimize design for: omni-directional mobility designs; suspension system options to reduce vibration and shock and the effects of shipboard operations; electrical power system alternatives (especially for battery-powered alternatives); and other trades as required. Develop a preliminary design. Prepare and forward a Phase I report.

PHASE II: Design and fabricate a working prototype of the (MP)2. This prototype system will undergo testing at a Navy test facility. (A portion of this testing is anticipated to occur aboard ship.)

PHASE III: Perform additional engineering development as a result of the Phase II test results. Manufacture production systems for shipboard applications. This program will transition to the Naval Aviation Systems Team (TEAM) PMA260 program office. The (MP)2 will be backfitted for use on all existing aircraft carriers and for the future carriers (CVN-76 and CVN-77) and the new carrier design CVX.

COMMERCIAL POTENTIAL: The technology that will be incorporated in the (MP)2 will be readily applicable to the airport equipment industry and the warehouse/material-handling equipment industry.

REFERENCES:
1) Multipurpose Mobility Platform (MP)2 System R&D Guidance Document, dated 8 May 1998.
2) Naval Air Warfare Center, Aircraft Division, Product Evaluation and Verification Department Letter Report: Omni-Directional Vehicle (ODV) Operational Field Evaluation, dated 30 November 1993.
3) Paper: New Family of Omnidirectional and Holonomic Wheeled Platforms for Mobile Robots; Francois Pin and Stephen Killough; IEEE Transactions on Robotics and Automation, Vol. 10, No. 4, August 1994.

KEY WORDS: Omnidirectional Wheels; Material Handling; Aviation Support Equipment; Electric Vehicles

N99-052 TITLE: Passive Obstacle Avoidance System

OBJECTIVE: A passive obstacle avoidance system for helicopter (or other airborne platforms) application that can detect 1 cm diameter wires at 600 meters is needed in order to avoid catastrophic accidents.

DESCRIPTION: The system should be low cost and operate in all weather conditions. One potential alternative is a mid-wave infrared (MWIR) or long wave infrared (LWIR) imaging system with 10E field of regard to allow wide field detection. As an option, a eye-safe laser range finder integrated into the detection system allows important range information. The system should include linear feature obstacle recognition and tracking algorithms for near instantaneous alarm triggering. The imaging system will also serve for ground target detection and as an all weather flying aid.

PHASE I: Determine technical feasibility, operating conditions and low cost of alternative technologies / approaches. This effort will consider research and development of appropriate imaging and ladar sensors for optimum wire detection at maximum ranges. Identification algorithms should be investigated to offer novel approaches for high probability of wire detection. The system should consist of imaging system, optional laser ranger, obstacle identification algorithms, software, and recording electronics necessary to identify, display and present alarm for a 1 cm wire at 600 meters.

PHASE II: Design, fabricate, integrate, and demonstrate a prototype airborne obstacle avoidance system.

PHASE III: Cost reduction, weight reduction, system hardened production effort.

COMMERCIAL POTENTIAL: As a low-cost system, this developed technology will have wide commercial application for law enforcement and search and rescue helicopter or other vehicle safety of operation.

KEY WORDS: Passive Imaging, Obstacle Avoidance, Helicopter

N99-053 TITLE: Advanced In-Line Fuel Sampling

OBJECTIVE: Develop a method for continuously monitoring the condition of aviation fuel aboard aircraft carriers, detecting the levels of particulates and contaminants in the fuel and giving an alert if those levels exceed prescribed allowances.

DESCRIPTION: The primary mission of the Aviation Fuels System is to provide aircraft-quality fuel to all U.S. and NATO Aircraft, and to support associated shipboard systems and equipment. This mission is accomplished through rigorous fuel sampling procedures using portable onboard test equipment and shore based laboratories to verify results. Presently, requirements as outlined in numerous directives require a dedicated group of specifically trained division personnel to take approximately 400 to 600 samples per day. They will visually examine the samples and periodically transport samples to a dedicated onboard facility for analysis, looking for traces of sediment and water.

Fuel sampling is required both prior to aircraft operations and periodically throughout the day. There are approximately 92 aircraft refueling hoses that require sampling onboard CV/CVN’s. All service tanks and in-use storage tanks require daily stripping prior to flight operations and periodically throughout the day. Each purifier (4 each) requires continuous monitoring and sampling during the purification process, which is about 18 hours a day, per unit. Additionally, all four 2000 GPM service filters require constant monitoring and sampling along with reclamation filtering, routine stripping, internal/external transferring and receiving fuel from along side tankers. A system that continuously and autonomously monitors the condition of the fuel and eliminates the need to conduct manual fuel sampling could reduce manning by an estimated 13 people, saving over $800K annually and nearly $41M over the life of the carrier. This system could all but eliminate costly onboard test equipment and provide data back to the air systems command real-time for determining engine performance specifications and maintenance failures trends. It would also reduce along side time during periods of underway replenishment by eliminating the time needed to perform sampling before fuel can be accepted, sampling procedures required during refueling evolutions, and costly monthly sampling requirements needed to verify accuracy of test equipment.

The proposed system would require sensors inside the pipe at various key points in the fuel system. These sensors must detect the levels of sediment and water in the fuel as it flows through the pipe. These levels would be displayed on control panels currently in use in the aviation fuels division. A warning indicator would trigger if levels exceed prescribed allowances. Current NAVAIR standards for fuel quality specify that water levels in jet fuel cannot exceed 5 parts per million (PPM) and sediment levels cannot exceed 2 mg/l. Sediment is defined as rubber, dirt, rust, sand, metal shavings and any other solid particulate.

PHASE I: Conduct a feasibility study which develops a concept for in-line fuel sampling for Naval aircraft. This system must be able to operate aboard aircraft carriers, but it should be noted that such a system would have application to shore air stations as well.

PHASE II: Develop, test, and operationally demonstrate the concept formulated under the Phase I effort at a land-based facility at the Naval Aviation Maintenance Training Group, NAS Pensacola, or similar facility modeled after the aviation fuels system aboard a carrier.

PHASE III: Produce the system as demonstrated in Phase II. The system would be transitioned to NAVSEA PMS-312 for retrofit to existing CV/CVN’s and PMS-378 for integration into the CVX-78 future carrier design.

COMMERCIAL POTENTIAL: The sensors and algorithms developed for ensuring the quality of aviation fuels aboard the aircraft carrier would directly translate to aviation fuels for commercial aviation operating on the ground, and could be adapted for use in other fluid applications as well, including continuous monitoring of drinking water.

KEY WORDS: Advanced Sensors, Fluid Monitoring

N99-054 TITLE: Autonomous Launch Bar Seating Check

OBJECTIVE: To develop a system that will automatically confirm whether the aircraft's launch bar is correctly engaged into the catapult's shuttle.

DESCRIPTION: A recent incident occurred on the USS Eisenhower where an F/A-18 aircraft was lost because the aircraft's launch bar was not properly seated in the catapult's shuttle. This condition resulted in the launch bar popping out of the shuttle during the launch stroke and the aircraft being launched at an end speed that was too low for flight. Luckily, the pilot was able to eject safely and lived. There were at least four similar incidents in the past two years. The job of checking to see if the launch bar is fully engaged in the shuttle falls to the Hookup Petty Officer (sometimes a safety observer is also involved). The hookup P.O. will make a visual check and sometimes kick the launch bar if it looks like it is not completely seated in the slot. This is the most dangerous job on the flight deck. To check the launch bar and shuttle engagement, the hookup P.O. must be positioned forward of and close to the engine inlet of the aircraft while the aircraft is at full, military power. There are numerous documented instances where the hookup P.O. or the safety observer got sucked into the engine inlet. A system that automatically checks to see if the launch bar is correctly seated in the shuttle and gives a positive or negative indication to the catapult officer and pilot prior to launch, could significantly reduce flight deck fatalities and launch-related mishaps.

The following is a synopsis of the launch process. (1) HOOKUP PREP STOP: Aircraft is stopped with the nose gear just aft of the AY (the beginning of the launch bar guide track). The Director tells the Pilot to extend his launch bar, which falls into the launch bar guide track. During this stop, a Cat Crewman will attach the Repeatable Release Holdback Bar (RRHB) to the rear of the nose landing gear. (2) TAXI ONTO CAT: After the RRHB is secure, the Director tells the Pilot to taxi forward. The launch bar and RRHB glide in the guide track. The RRHB engages the hold back buffer hooks and the aircraft pulls them along until the launch bar drops in front of the cat shuttle and the buffer hits its stops. A Cat Crewman remains with the nose gear ensuring proper hook-up. (3) CAT TENSION: Once the launch bar is positioned in front of the shuttle, the Director simultaneously commands the Pilot to full military power and the shuttle to be tensioned. Tensioning hydraulically moves the shuttle forward with several thousand pounds of force, tightening the launch bar and RRHB system. This is when the Hookup P.O. checks for proper fit and then runs away. (4) FINAL CHECKS & LAUNCH: The pilot then does a full flight control check (Awipeout) by moving the control stick and rudders to their full deflections several times. If all is well, he salutes the Cat Officer, indicating he is ready for launch. After receiving the pilot's salute, the Cat Officer does one final check of the catapult settings, looks for any obstructions or conflicts, ensures he has a thumbs up from all his crewman, and then commands launch.

The following is a discussion of the technical challenges and relevant information. The cat tensioning step takes between 6 and 10 seconds, so any autonomous system that checks for proper fit must give an indication in no greater than 10 seconds. The launch bar is attached to the aircraft's nose landing gear. At the end of the launch bar is a T-head that is essentially cylindrical in shape, with a diameter of about 2 inches and a length of about 5 inches (the launch bar's width is about 2 inches). As the aircraft taxies forward, the T-head rides along the top of the spreader assembly, which is essentially two side plates a little less than 5 inches apart and attached to the shuttle. The T-head rests just in front of the spreader where the U-shaped slot (the Athroat) is located. (There is an equivalent slot on both side plates.) Once the catapult is tensioned, the spreader jerks forward to Agrab the T-head. For the T-head to be seated properly in the throat, the entire throat must make physical contact with the T-head. Both parts are unpainted steel. Any equipment or sensor that sits on or near the spreader must be able to withstand considerably high temperatures and mass flows from the exhaust of the launching aircraft. Any equipment or sensor that is physically attached to the spreader assembly would also experience a very significant force toward the spreader during the launch stroke and away from the spreader during catapult deceleration (catapult piston striking the water brake). If a sensor sits on the spreader itself, it is suggested that it be wireless, since the shuttle acceleration would quickly destroy any electrical cables that are connected to it. Also keep in mind that operations are conducted in all ranges of ambient light (day, dusk, night), in all weather, in the existence of considerable radio frequency (RF) and electromagnetic (EM) interference, and in the environment of a pitching and rolling ship. System accuracy should be given special focus, since the system must ultimately outperform the human observers. Because aircraft flyaway weight is always a concern, and it is more difficult to affect changes to the aircraft than it is to affect changes to the catapult or ship, higher consideration will be given to approaches that can accomplish the stated goals without need to modify the aircraft or the launch bar. Modifications to the aircraft are allowed, but discouraged.

PHASE I: Conduct a study which develops a concept for autonomously checking the launch bar seating and assesses the feasibility of that concept.

PHASE II: Develop, test and operationally demonstrate the concept formulated under the Phase I effort. The testbed may be a land-based facility (such as the test catapults at Lakehurst or Patuxent River) or shipboard, depending on the complexity of the concept and its integration into the ship.

PHASE III: Produce the system as demonstrated in Phase II. The system would be transitioned to NAVSEA PMS-312 for retrofit to existing CV/CVN's, if applicable, and PMS-378 for integration into the CVX-78 future carrier design.

COMMERCIAL POTENTIAL: This technology could have numerous applications in the commercial sector, including railroads (checking to see if railroad cars are hooked to each other) and trucking (checking to see if the trailer is mated to the cab). Any application where physical contact must be monitored could benefit from the technologies developed under this topic.

REFERENCES:
Available via Defense Technical Information Center (DTIC) support of Small Business Innovation Research Program:
NAEC Drawing No. 614847, Spreader
NAEC Drawing No. 510624, Spreader Assembly
NAEC Drawing No. 607770, Launch Bar

KEY WORDS: Sensors, Sensor Monitoring, Aircraft Launch

N99-055 TITLE: Aircraft Wireless Intercommunications System (WICS)

OBJECTIVE: Develop an in-flight wireless communications system that can be fully integrated with current helmet system and is not subject to interception by electronic warfare threats.

DESCRIPTION: The current Intercommunications System (ICS) for the enlisted aircrew requires a lengthy cord to allow the aircrew to maintain communication with the pilots. The ICS cord is cumbersome and requires the aircrew's constant attention to avoid entanglement while performing their duties in and about the aircraft. An improved ICS capability is required to allow the aircrew unimpeded movement throughout the cabin and to a limited distance outside the aircraft. The WICS will provide greater mobility, improve work efficiency and enhance safety by eliminating the constant trip hazard and distraction associated with the current long communications cord used in the aircrew ICS. The proposed system must be compatible with current headgear or require minimal modification. The proposed system must not be subject to interception by electronic warfare threats. The proposed system's power supply must provide power for missions of 12 hours in length and must be compatible with aircraft power. Proposed system must be fully compatible with any active / passive noise reduction systems currently in development and must not cause any electronic interference with aircraft. It is desirable that the final system use encryption and communication technology similar to those used in new, non infra-red, Ato-be-fielded survival radio systems.

PASE I: Demonstrate the ability to provide a small, lightweight, multi-user, functional wireless system with work toward elimination of outside electronic threat. A breadboard demonstration unit is desirable

PHASE II: Build and test a working WICS system described above and eliminate product risks before a Phase III program.

PHASE III: Perform an EMD program on the WICS to prove out a system that is fully compatible with current life support system.

COMMERCIAL POTENTIAL: The technology can be used in any high noise environment where portable (non-hardwired) communications is essential.

KEY WORDS: communications; wireless; ICS; helmet

N99-056 TITLE: Inertial Sensor Technology

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: To extend the performance capabilities of miniaturized inertial sensors for use in critical Navy applications, such as head-tracked weapon targeting systems; greatly improved helmet-mounted displayed (HMD) performance in Naval Aviation simulators and mission rehearsal/planning systems; and inexpensive, accurate instrumentation/test data collection equipment for flight testing and telemetry.

DESCRIPTION: Inertial sensors are essential components of Inertial Navigation Systems (INSs) used in guidance instruments on aircraft, ships, and weapon systems. Miniaturization of the basic INS components (angular rate gyroscopes and linear accelerators) has led to new uses of inertial sensors in automobiles (air bag release sensors). Further size and weight reductions resulting from micromachining technology now permit their use as inexpensive, high-fidelity sensors for human body and object tracking. Inherent properties of inertial sensors offer the potential for high resolution, low latency, unlimited range/working volume, and immunity from noise, electromagnetic interference (EMI), and line-of-sight obstructions. One or more of these problems plague all other tracking technologies. Inertial sensors measure angular rates and linear accelerations directly; therefore, they also greatly improve motion prediction capability.

In order to achieve the full potential of the technology, advanced sensor fusion based on Complementary, Extended, or other new Kalman filter techniques is required to perform dynamic correction of inertial sensor drift and precise prediction of future object states. Increases in computational power allow formulation and validation of high-order, large-state vector algorithms that can be optimized for a given error tolerance in either position or orientation accuracy.

PHASE I: Analyze existing and expected future inertial sensor performance. Identify any deficiencies in sensor characterization and improvements required. Identify mathematical, numerical, statistical, or other techniques needed to formulate and implement optimal sensor fusion algorithms with the properties described above. Identify one or more existing or new Naval Aviation operational, training, mission planning/rehearsal, or other application to demonstrate improved fidelity, functionality, or reduced costs achieved from the use of advanced inertial sensor technology. Determine the mathematical proofs, tests, and analyses to be performed, and the data to be collected, to fully validate new inertial sensor processing and sensor fusion formulations. Develop an implementation methodology and design concept for the Phase II prototype.

PHASE II: Develop improved inertial sensor characterization methods. Develop advanced processing and sensor fusion algorithms. Provide mathematical proofs of optimality. Code the models in the software. Integrate developed software with the inertial sensor hardware and a computing system. Install a prototype on a Navy Aviation system for evaluation. Test and verify the system's performance and ease of use, and quantify improvement over other tracking solutions in fidelity and cost.

PHASE III: Refine and bundle the developed technology as a product suitable for use by commercial and military developers and system integrators.

COMMERCIAL POTENTIAL: Compact, high-performance instrumentation equipment for flight testing and other data collection applications; cockpit sensors (e.g., for head-tracked targeting using a flight HMD/HUD); industrial/professional augmented reality systems for maintenance, inventory, surgery, simulation, training, and teleoperation systems and human/object motion capture and analysis systems; virtual walkthroughs; side effects/simulator sickness reduction in head-mounted display systems; and human factors/psycho-physical/sensorimotor studies. The developed technology will have broad application and mass-market potential for consumer and location-based entertainment systems. Applicable to all systems requiring low to moderately priced tracking sensors.

REFERENCES:

1) http://www.cs.unc.edu/~tracker
2) http://www.cs.unc.edu/~olano/papers/latency (Kalman Filter Home Page)
3) http://www.cs.unc.edu/~welch/kalmanLinks.html (Predictive Tracking Notes Home Page)
4) http://www.cs.unc.edu/~weberh/local.html

KEY WORDS: Inertial sensors; INS; Head-Tracking; HMDs; Targeting; Mission Planning; Mission Rehearsal; Instrumentation; Kalman Filters; Motion Capture

N99-057 TITLE: Advanced Control Features to Adapt Low-Cost Digital Display Based Projectors to Training Simulation

SCIENCE/TECHNOLOGY AREA: Manpower, Personnel, and Training

OBJECTIVE: To develop a capability that allows advanced adjustments of a digital-based projector to effect lower cost of new immersive display systems, as well as to lower the cost of replacing obsolete light valve projectors.

DESCRIPTION: Current digital-based projectors, such as LCD or micro-mirror, provide high luminance at low cost, making them potentially ideal for training simulation. However, their usefulness is greatly limited due to limited adjustability. This limitation also precludes the use of low-cost graphics boards. For instance, dome displays using multiple projectors require warping of the image to correct for distortion at the trainee’s eyepoint and to stretch the images to eliminate gaps and overlap between the projected images. This necessitates the use of high-cost CRT-based projectors. CRT-based projectors are inherently dim and require expensive replacement of the CRTs as they degrade. As a result, system cost increases due to special hand-worked high-gain screens, and luminance values are less than desired. Light valve-based projectors provide more light, but are very high cost. Current digital-based projectors have some controls, such as optical keystone correction and digital resizing and reformatting. The digital manipulation of the video image could be increased to include useful functions, including the following: 1) regionally controlled image warping to allow distortion correction and edge matching; 2) regionally controlled brightness to allow uniform brightness and edge matching; 3) user-controlled gamma function; 4) user-controlled pixel-based gain to allow for compensation of screen blemishes; and 5) adjustable edge boundary brightness rolloff to allow blending of overlapped projector images.

PHASE I: Identify which adjustments will be user-controlled. Identify algorithms required to perform the desired types of adjustments. Identify hardware required to perform necessary functions, including block diagrams of required algorithms and system architecture. Identify required performance of key system components, such as memory, bandwidth, and digital processing, which would be anticipated for the Phase II manufacturing effort in years 2000 and 2001. The system should anticipate performance commensurate with digital-based projectors of 2000 and 2001. If the proposed solution is a separate box or board from the projector, identify all related compatibility issues. If the proposed solution is a box or board separate from a projector, identify any other functional advantages which could be applied to driving a helmet-mounted display (i.e., distortion correction, image lag compensation, etc.).

PHASE II: Develop a multichannel prototype system based on Phase I findings. Demonstrate the system's functional capabilities.

PHASE III: Develop a commercial product based on Phase II.

COMMERCIAL POTENTIAL: Real-time, high-performance simulation, such as flight trainers. The ability to create high-quality, low-cost seamless video walls has wide commercial applications, including replacement of movie theatre projectors. Advanced features for digital display-based projectors would require low hardware costs by 2001, thereby becoming widespread. If an external converter board or box is developed instead of a circuit change within the projector, then the HMD industry will benefit with reasonable cost methods of distortion correction and reduction in image lag. (Both are important for reducing simulator sickness.) HMD could also be updated at a low refresh rate, thereby greatly improving the performance of the image generator.

REFERENCES: Stanney, K.M. and Salvendy, G., et al, "After Effects and Sense of Presence in Virtual Environments: Development of an R&D Agenda," International Journal of Human-Computer Interaction, 10(2), 1998, pp. 135-187.

KEY WORDS: Display; Simulation; Imaging; Visual

N99-058 TITLE: Master Training Plan (MTP) Generator for Fleet Replacement Squadrons (FRSs)

SCIENCE/TECHNOLOGY AREA: Software

OBJECTIVE: To improve quality and accuracy of MTPs for FRSs. In addition, reduce the time and effort required to build them so that they can be used more effectively in the planning and allocation of resources for, as well as the conduct of, flight training.

DESCRIPTION: Each FRS is required to build an MTP for each course to accurately map the calendar time needed for completion of the course, or any segment of the course. While it is relatively simple to map the Master Course Schedule (MCS) onto a Master Training Plan for a lock-step course, it is no simple task for the highly individualized courses typical of an FRS. Complex and very dynamic scheduling of events is required at the FRSs in order to accommodate the uncertainties of weather, resource availability, and individual differences in the highly individualized courses. At the same time, these schedules must operate within the constraints of expensive and, consequently, limited resources (e.g., aircraft and flight simulators). Developing and maintaining an accurate MTP is currently an arduous, labor-intensive task. (At one FRS, it takes three people three months to develop its MTP annually and an additional full-time person to maintain it.) However, an accurate MTP is vital to the effective planning and operation of training at an FRS and to the maintenance of Fleet readiness. For planning purposes, the MTP provides a predictor of how long it will take a new student to complete the required curriculum. It also indicates when those already enrolled in training may be expected to complete that training. In addition, it is used as a yardstick against which students can be measured to ensure that training is progressing at an appropriate rate. It is also important to assess the impact of changes to the curriculum, resource availability, or student loading upon the MTP so that changes in course completion times may be anticipated and the cost/benefit of proposed changes accurately evaluated. This research will result in the development of a set of software tools to use the available course curriculum, training resources, and enrollment data, together with historical stochastic data, to accurately build and modify MTPs for the FRSs.

PHASE I: Analyze the detailed generic data requirements for building MTPs for FRSs. Identify the source for each data type and how its acquisition, tracking, and maintenance can best be automated. Analyze the mathematical, numerical, statistical, heuristic, or other relationships that exist between these data and the MTP for an FRS, and determine those most appropriate for application to automating the building of the MTP. Identify the best algorithmic or other automated approach methods for applying the identified relationships to the source data so as to develop the elements of the MTP. Determine the analyses and validation tests needed to ascertain the accuracy of a tool for building MTPs for FRSs. Develop an implementation methodology and design concept for a Phase II prototype tool for building MTPs for FRSs.

PHASE II: Develop a prototype set of generic automated software tools for building the MTPs for FRSs. Install a prototype set of generic software tools at a Navy FRS, and provide implementation and technical support for an on-site beta test evaluation of the software at that FRS. Develop an automated test procedure for validating and refining the MTP for an FRS and use this for testing the accuracy of the MTPs generated by both conventional and automated means at the beta test site FRS.

PHASE III: Refine the MTP generation and testing technology into a product suitable for use by commercial and military developers and system integrators. Provide the refined software at a variety of advanced, weapons platform-specific, flight training squadrons, and provide implementation, training, and technical support for its use by other services involved in the training of flight personnel. Apply the technology developed for dealing with uncertainty in planning to other highly individualized training applications constrained by limited resources.

COMMERCIAL POTENTIAL: The techniques developed will have application to resource allocation problems involving fixed sets of loosely coupled tasks or events when several of those events are tightly constrained by a dynamic set of variables. Application of these techniques will permit improved analysis of large complex processes that are not currently amenable to conventional analysis and will lead to more effective planning and allocation of resources for these processes. Processes to which these techniques might be applied include battle force management and industrial process control, as well as individualized training.

KEY WORDS: Optimization; Resource Utilization; Planning Resource Allocation

N99-059 TITLE: <u>Multispectral High-Fidelity Radar Scene Generator</u>

SCIENCE/TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: To develop the algorithms and efficient processes for producing high-fidelity, wide area, radar scenes using geo-specific multi-spectral data sets and propogation codes for application in siting and predicting the performance degradation of radars (military/FAA) under adverse environmental conditions.

DESCRIPTION: Radar system performance frequently has to be simulated for specific scenarios in different parts of the world. The scenarios require accurate representation of background scattering (clutter) and propagation effects. Use of standard data bases, such as DTED/DFAD, produce only marginal fidelity and generally have too coarse a resolution to portray radar reflectivity accurately. Moreover, propagation phenomena can substantially change the levels of clutter received by the radar, masking target returns. This effort will develop the tools for high-resolution, physics-based radar scene generation using geo-specific multispectral data from multiple sources and will integrate with high-fidelity Parabolic-Wave Equation (PWE) propagation code. The integrated scene will be coupled to radar sensor models, which will enable true end-to-end radar performance simulation in real-world conditions.

PHASE I: Develop algorithms and efficient processes to produce high-fidelity radar scenes using multispectral data sets, and integrate with the propagation code and radar sensor models. A sample scene shall be produced and the process validated against measured data. The efficient processing design shall be a modular, open architecture to facilitate upgrades, integration, and interoperability with radar sensor models.

PHASE II: Develop, test, and demonstrate that the design architecture that was formulated under the successful Phase I effort is capable of producing deterministic, high-fidelity scenes on a worldwide basis. In addition, demonstrate end-to-end simulation capability with frequency domain sensor models.

PHASE III: Produce the scene generation capability for use in tactical decision aids, mission simulators, and training systems.

COMMERCIAL POTENTIAL: The new tools and methodology for radar scene generation and clutter prediction will enable improved siting of radars, better coverage predictions under adverse environmental conditions, and improved training for commercial airborne weather radars that must contend with clutter backscatter from the terrain and sea.

KEY WORDS: Radar; Algorithms; Processes; Propagation

N99-060 TITLE: <u>Human Sensory Physiological Models for Centrifuge-Based Flight Environment Training (CFET) for Recognition of Disorientation and Recovery from Out-of-Control Flight</u>

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: To develop a capability to train pilots to recognize disorientation in a dynamic sustained-g environment and recover from out-of-control flight situations.

DESCRIPTION: The following is a partial list of out-of-control flight situations: Flat spin (asymmetrical thrust); Inverted flight; Inverted spin; Backward acceleration; Stalls; Zero airspeed; Incipient spin; Steady-state spin (centerline thrust); Positive Gx/high yaw rate spin; Negative directional stability; Disorientation (G-Stress); Performance degradation under G-Stress;Post G-LOC performance. Recovery from some of these flight situations had been taught in the T-2C aircraft. The T-2C aircraft is leaving the inventory and the replacement, the T-45 aircraft, cannot be used to train in recovery from these out-of-control flight situations. The question is whether CFET can be reconfigured to provide this training. Current CFET technology has been developed with computer control dual axis to provide a basic capacity to allow growth for a variety of recovery training capabilities not yet determined.

PHASE I: Analyze and identify the spatial disorientation and out-of-control flight situations amenable to adaptation as CFET out-of-control flight recovery programs. The criterion for amenability would be the predicted effectiveness of the physiological sensory models for each out-of-control flight situation for adaptation as a CFET flight recovery program.

PHASE II: Based on the results of Phase I, develop the associated human sensory physiological models and performance specifications for design and development of the centrifuge gondolas and flight control algorithms required for CFET flight recovery training. Determine the analyses and validation tests needed to ascertain the accuracy of the human sensory models proposed. Verify, validate, and test the senosory models to ensure CFET application.

PHASE III: Based on the results of Phase II, develop training system functional descriptions that could be used to design, develop, and test the hardware, software, and courseware concept for military CFET flight recovery programs. This activity includes the design and development of performance criterion for testing and acceptance of the individual CFET flight recovery programs.

COMMERCIAL POTENTIAL: Out-of-control flight situations are not unique to military aircraft. The entire aircraft industry would benefit from a curriculum designed for training recovery from out-of-control flight situations.

KEY WORDS: G-LOC; Spin; Spatial-Disorientation; Recovery

N99-061 TITLE: Hostile Urban Entities for Simulators

SCIENCE/TECHNOLOGY AREA: Manpower, Personnel, and Training

OBJECTIVE: To develop the repository of software objects representing urban hostile entities.

DESCRIPTION: Military operations in urban combat environments are influenced by the political nature and climate of the dictating situation. As a result, the rules of engagement governing military personnel actions can be drastically different and potentially counter-productive if applied incorrectly. The limitations imposed on forces for political and strategic reasons often constitute significant obstacles to pure military mission accomplishment. In the reactionary environment of urban combat, awareness of complex hostile behaviors and political influences is crucial to the successful time critical application of the governing rules of engagement. Consequently, simulation based training to successfully execute missions in urban combat environments becomes a critical component of the current naval training efforts. New simulators are planned to be developed to address these new training requirements. With each new simulator, there is a need for maintaining its computer controlled urban oriented entities with which a trainee can interact. The entities can represent individuals, equipment, weapons, structures, causal effects, postures, actions, and behaviors of hostile and ally forces.

A common problem with the development of a new class of simulators is the effective sharing and reuse of data. Typically, each new simulator tends to set up its own infrastructure to acquire and represent the data necessary to run the simulator. To address the problem, the primary goal of the project is to foster the effective and efficient reuse of urban threat data for simulators. During the project effort, a software model for acquiring, maintaining, and using urban hostile entities will be developed and tested on selected simulators. Entities will be characterized by properties of urban environment, which are comprised of: 1) physical level that describes model of human movements and performance degradation; 2) reactive level that selects immediate actions; and 3) reasoning level that provides situation assessment and planning capability.

PHASE I: Investigate capabilities of current software modeling technologies and develop the urban hostile entities concepts.

PHASE II: Develop and implement beta prototypes of the repository using an object-oriented paradigm. Interface the repository with selected simulators to enhance naval aviation training.

PHASE III: Transition of the Phase II prototypes into an integrated repository system. Field-test system and implement revisions.

COMMERCIAL POTENTIAL: Software products resulting from this project can be used by various paramilitary and nonmilitary services with needs for training to operate in urban environments.

REFERENCES:
1) "Department of Defense Modeling and Simulation (M&S) Master Plan," http://www.dmso.mil/docslib/mspolicy/msmp/1095msmp/.
2) Barr, T. and Clark, K., "Scenario Preparation of DIS," Proceedings of the 14th Interservice/Industry Training Systems and Education Conference, 1993.
3) Feiner, S. and Beshers, C. "Worlds Within Worlds: Metaphors for Exploring Dimensional Virtual Worlds," Proceedings of 3rd Annual Symposium on User Interface Technology, Snowbird, Utah, October 3-5, 1990, ACM, New York.
4) Marine Corps Master Plan.

KEY WORDS: Rules of Engagement; Urban Combat Environments; Reuse of Urban Threat Data for Simulators

N99-062 TITLE: Visualization of Weapons Effects for Training and Test and Evaluation

SCIENCE/TECHNOLOGY AREA: Human-System Interfaces

OBJECTIVE: To develop a low-cost system enabling visualization of weapons effects for training and test and evaluation activities.

DESCRIPTION: There is a need within the Navy and other services to develop tools with which to model, present, and visualize weapons effects. The ability to navigate around, in, and through simulated target combat systems would afford operators and design engineers a unique and powerful training and analysis tool. Coupled with physics-based models, visualization in this manner would provide the user with accurate, perceptible displays of information not readily understood in raw data format.

In distributed training and simulation, battlefield casualty predictions are often based upon a probability of weapon hit and kill, assigned based upon various forms of empirical data or heuristics. Using visualization, this raw data could be converted to provide meaningful feedback to planners and warfighter personnel for better understanding of system effectiveness concerning tactics and weaponry.

The Navy desires to develop an ability for a person to observe, from any aspect angle, the effects of a weapon impact on a ship, aircraft, or land-based target. The visualization can be outside or within the target as desired. In this manner, a person can observe the penetration of the weapon, fragmentation, stress, and heat distribution and be able to assess the damage to the equipment and personnel. This visualization can enhance training and greatly influence behavior.

PHASE I: Conduct relevant literature and technology surveys, to include interface with Navy and other service weapons survivability laboratories and vulnerability/lethality activities. Develop concept papers, detailed plans, and functional requirements for a visualization system, enabling better understanding of weapons effects for use in training and analysis.

PHASE II: Develop a fully functional prototype, and provide demonstration scenarios applicable to training based upon available, validated mathematical models. Determine applicability to high-level architecture.

PHASE III: Develop a fieldable device and process to integrate this new technology into training programs and engineering processes.

COMMERCIAL POTENTIAL: This low-cost visualization system would have great value to the military for all warfare systems where weapon effects are a consideration and for trainers, designers, and warfighters. The potential market for this system in the commercial market would be in safety engineering activities in areas such as automotive, ship, or aeronautical structure design. Related areas could include accident investigation, driver training, and post-crash analysis.

REFERENCES:
1) Gaver, Donald P.; and Jacobs, Patricia A., ADA329197, "Probability Models for Battle Damage Assessment (Simple Shoot-Look-Shoot and Beyond)," Naval Postgraduate School, Monterey, California, Department of Operations Research, Report No. NPS-OR-97-014, August 1997.
2) Hyrskykari, Aulikki, ADA312603, "Development of Program Visualization Systems," LCGL Collection, Fort Belvoir, Virginia, Report No. REPT-A-1995-3, April 1995.
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4) Coleman, Julie L., ADA309511, "Human Response to Nuclear and Advanced Technology Weapons Effects," Armstrong Laboratory, Brooks Air Force Base, Texas, Occupational and Environmental Health Directorate, Report No. AL/OE-TR-1996-0033, May 1996.

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6) Anderson, Charles E., Jr., and Littlefield, David L., ADA281384, "Pretest Predictions of Long-Rod Interactions With Armor Technology Targets," Southwest Research Institute, San Antonio, Texas, April 1994.
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8) Brode, Harold L., ADB149836, "Airblast from Nuclear Bursts. Analytic Approximations," Pacific-Sierra Research Corporation, Los Angeles, California, Report No. PSR-1419-3, July 1987.
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10) Dzwilewski, Peter T., Matuska, Daniel A., Sues, Robert H., and Zessin, Cynthia J., ADB210572, " Numerical Simulations of Conventional Weapons Effects-Airblast, Bomb Fragmentation, Ground Shock, and Cratering," Massachusetts Institute of Technology, Cambridge, 1 May 1996.
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KEY WORDS: Data Visualization; Training; Engineering Tool; Finite Element Analysis; Battlefield Visualization; High-Level Architecture; Crash Analysis; Accident Investigation

N99-063 TITLE: Multiplatform, Integrated Virtual Urban Warfare Simulation

SCIENCE/TECHNOLOGY AREA: Software/Computing Technology and Modeling and Simulation

OBJECTIVE: To develop and demonstrate multiplatform motion-based simulated environments.
DESCRIPTION: Demonstrate the feasibility and applicability of integrating multiple simulated vehicle platforms into single simulator platforms as either a test bed for virtual warfare simulation or for training. Motion-based simulation platforms have traditionally been limited to simulating a single vehicle environment at a time. This SBIR topic would be to investigate and demonstrate the feasibility of simulating multiple vehicle environments simultaneously, with independent crew control of each vehicle. Multiple vehicle environments include a number of the same vehicle type operating together or in different areas of the urban battlefield and one or more of each of a number of different vehicle types operating together or in different areas of the urban battlefield. The latter, as an example, may include simultaneous simulation of one or more helicopter types and one or more ground vehicle types, all independently controlled and each with full motion; high-fidelity visuals; realistic crew-station mockups with instruments and controls; and high-fidelity audio (both communications and vehicle and environment sounds).

PHASE I: This phase would be to investigate the feasibility of such a simulation, design a platform to demonstrate this simulation, and develop a test program to validate the demonstration.

PHASE II: This phase would provide a scaleable software prototype and validation of the Phase I-developed techniques for simultaneous control of multiplatform motion-based simulations.

PHASE III: During Phase III, the prototype will be fully scaleable to support the commercialization of the product.

COMMERCIAL POTENTIAL: The technology for simultaneous control of multiplatform motion-based simulations will result in commercial products that can be utilized across various motion-based simulations, with the entertainment industry being primarily targeted.

REFERENCES:
1) "Department of Defense Modeling and Simulation (M&S) Master Plan," http://www.dmso.mil/docslib/mspolicy/msmp/1095msmp.
2) Marine Corps Master Plan.

KEY WORDS: Multiple Simulated Vehicle Platforms; Virtual Warfare Simulations; Urban Battlefield; Realistic Crew-Station Mockups

N99-064 TITLE: Advanced Concepts in Terrain Modeling and Rendering

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: To develop a modeling technique and rendering algorithm for terrain that alleviates known problems associated with the traditional approaches of terrain generation for a visual data base.

DESCRIPTION: Develop a terrain level of detail control criteria based on subtense in screenspace as opposed to distance. In this method, the highest level of detail could be ported right from the source data, and, in real time, vertices and edges could be collapsed, depending on whether the screenspace subtense of a terrain polygon is below a user-specified value.

Also, develop an algorithm for marking certain terrain vertices as noncollapsable to alleviate problems with terrain and feature correlation in a visual data base. This intelligent processing could occur during the data base generation (i.e., when the feature data is draped onto the terrain) or during real time (i.e., when a relocatable tactical player is placed on the terrain).

PHASE I: Provide a feasibility study for the development of modeling techniques for better correlation of features and terrain, as well as better terrain rendering techniques that incorporate more than just distance as criteria for a terrain level of detail switching. These techniques would have to be compatible with standard modeling packages, image generators, and graphics accelerators.

PHASE II: Develop, test, and operationally demonstrate the modeling and rendering techniques formulated under the Phase I SBIR effort.

PHASE III: Produce the modeling and rendering methods demonstrated in the Phase II effort.

COMMERCIAL POTENTIAL: The new methodology would benefit the commercial simulator industry, video games industry, and entertainment industry.

REFERENCES:
1) MIL-STD-188/-182
2) MIL-STD-l88/-183

KEY WORDS: Modeling; Visual Data Bases; Terrain

N99-065 TITLE: MIP Insertion for Geo-Specific Imagery

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: To dramatically improve the appearance of textured terrain in a visual data base when viewed from distances closer than the distance at which the photograph was taken.

DESCRIPTION: The insertion of a higher-resolution, geo-typical texture pattern in the top of the "MIP pyramid" would enable the user to receive valuable cues at lower altitudes. The placement of geo-typical imagery could be governed by the sampling of real features in such NIMA products as Digital Feature Analysis Data (DFAD) or Vector Smart Map (VMAP). Also, with the inserted MIP, levels could be used to add a color bias to the satellite imagery, thus alleviating the monochrome look. Furthermore, if the sampled geotypical textures are stored in resident memory, high-resolution geospecific imagery could be obtained with reasonable texture bandwidth.

(*The term "MIP map" refers to the most popular texture level of detail control algorithm. The acronym is short for the Latin phrase "Multum in parvo" (many things in one place).)

PHASE I: Provide a feasibility study for the insertion of high-resolution geotypical imagery into the geospecific MIP pyramid. Issues to be investigated would include the off-line processing and real-time processing.

PHASE II: Develop, test, and operationally demonstrate the MIP insertion methods formulated under the Phase I SBIR effort.

PHASE III: Produce the MIP insertion methods demonstrated in the Phase II effort. This will be the included as a data base development tool.

COMMERCIAL POTENTIAL: New methodology can be used for the entertainment and video games industry.

REFERENCES:
1) MIL-STD-188/182
2) MIL-STD-l88/183

KEY WORDS: Visual Data Bases; Geospecific Imagery; MIP Maps

N99-066 TITLE: Practical Polarization Metrology for the Fiber-Optic Gyroscope (FOG)

SCIENCE/TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop a United States vendor of a FOG polarization metrology device that can be used both by developers and manufacturers of FOG instruments.

DESCRIPTION: The Navy is developing a highly accurate, low-cost FOG device as part of the Precision Strike Navigator (PSN) program currently funded by ONR. The PSN is scheduled to transition to production development in FY00. To develop the optical components needed for the PSN, a polarization metrology device, known as a White Light Interferometer (WLI), is needed. The WLI is usually a research-grade, in-house-developed device. The PSN program has access to research-grade, in-house-built WLIs. A French company currently markets a WLI; however, it is not designed to accommodate the dynamics of preproduction technology development. An instrument is required that: 1) can perform the rapid and continuous scanning needed for real-time troubleshooting; 2) has at least 80dB of dynamic range to characterize low-level coherence effects; 3) is not susceptible to small amplitude fluctuations of the input signal; 4) can scan at least 100 mm with submicron resolution; and 5) has a Fourier Transform capability to display the wavelength spectrum.

PHASE I: Develop a breadboard device and deliver it to the Government for evaluation. This device will be constructed on a suitable optical table having easily available input/output optical couplers for testing a variety of FOG devices. It should have a PC Windows-based software/computer for extensive and flexible control and access of instrument components, as well as numerical routines that are used for extracting the data.

PHASE II: Develop a preproduction device and deliver it to the Government for evaluation. This instrument will be in a standalone mainframe package with a user-friendly control panel and PC-based software/computer with comprehensive operating instructions.

PHASE III: License to manufacturer or set up for commercial manufacturing.

COMMERCIAL POTENTIAL: This device would offer a novel metrology solution to all FOG producers around the world. This instrument provides a practical polarization metrology capability that can test not only FOG devices, but many other integrated electo-optical polarization-sensitive components.

REFERENCES:
1) Patent 5,422,713, 6 June 1995, Birefringent Waveguide Rotational Alignment Method Using White Light Interferometry.
2) Kasumasa Takada, Kasunori Chida, and Juichi Noda, Appl. Opt. Vol. 26, No. 15, pp. 2979-2987.

KEY WORDS: Polarization; Metrology; Fiber-Optic Gyroscope

N99-067 TITLE: Offboard Processing for Air-Deployed Acoustic ASW Sensors

SCIENCE/TECHNOLOGY AREA: Sensors

OBJECTIVE: To use autonomous in-sensor processing and decision-making techniques to enhance performance of future airborne ASW systems.

DESCRIPTION: Future airborne ASW systems will increasingly rely on acoustic-receiving buoys with large numbers of hydrophones and, consequently, large numbers of beams. With buoy-to-aircraft data link limitations, as well as aircraft processing limitations, data that could contain the weak target information may never reach the operator. This SBIR will address how offboard, autonomous processing can be used to provide a force-multiplying effect for the air ASW mission, primarily through active search, but supplemented by passive and nontraditional methods.

PHASE I: Define innovative system-level concepts that maximize the performance of autonomous sensors. Define processing and classification techniques that exploit the full band of signals available in each beam, but fit within the cost/power consumption limitations of a battery-powered processor embedded in a self contained, offboard sensor.

PHASE II: Develop a working prototype of the techniques defined under the Phase I effort. The prototype system will be capable of field operation and will be used to analyze and demonstrate the system and processing concepts using real data furnished by the Government.

PHASE III: Implement the systems concepts and processing techniques in a configuration and package that can be left behind at-sea to process data and transmit results back to a monitor platform.

COMMERCIAL POTENTIAL: The concepts and processing techniques developed under this task can be applied to any kind of commercial systems, sonar or otherwise, where remote site data gathering is required and where the available data link bandwidth cannot support the volume of data collected (e.g., monitoring or surveillance systems where "smart" processing must sort through volumes of data to send an "alert" message with amplifying information over a cellular telephone line).

KEY WORDS: Antisubmarine Warfare; ASW Signal Processing; Offboard Sensors; Autonomous Processing; In-Buoy Processing, Detection, and Classification

N99-068 TITLE: Integration of Mode S into Identification Friend or Foe (IFF) Systems

OBJECTIVE: Determine if integration of Mode S interrogation capabilities is feasible onboard moving platforms, specifically surface combatants and airborne platforms. Incorporate Mode S interrogation capabilities into existing IFF systems. Optimize the use of available Mode S information for improved combat identification. Provide valuable Mode S information to combat systems and data links for distribution throughout a given theater.

DESCRIPTION: IFF systems are used for air traffic control (ATC) purposes, and critical for positive, secure, friend identification. It is essential for these systems to properly identify targets and provide combat/weapons systems with accurate identification for target tracking and friendly target discrimination. Due to deficiencies in Air Traffic Control Radar Beacon System, Mode S was developed and implemented by civil authorities. Although many commercial land based sites have Mode S interrogation capabilities, implementation onboard mobile military platforms is difficult due to lack of physical space, antenna type and size, and the inherent instability of moving platforms. Use of Mode S information is valuable for situational awareness and identification of noncombatants. Most commercial aircraft in the United States and Europe are being fitted with the Mode S transponders. Due to the complexity of Mode S, innovative research needs to be performed to:

1. Determine if Mode S interrogation capability can be implemented on moving and space confined platforms (surface ships / aircraft).
2. Determine if existing IFF interrogator systems can be modified to gather Mode S data.
3. Determine if these modified systems can provide combat systems and data links with valuable information for dissemination across the entire battle space.
4. Modify existing IFF systems and integrate Mode S interrogation capabilities into the combat/weapons systems.

PHASE I: Perform a comprehensive study of Mode S, identifying the feasibility of implementation onboard moving, space confined platforms and the tactical benefits to the military. Develop various schemes for acquiring Mode S equipped aircraft. Propose an architecture for adding a Mode S interrogation capability to shipboard IFF systems to include operational issues such as use of Mode S datalink, displaying Mode S data, managing a 24-bit aircraft address database, and adding Mode S data into existing tactical datalinks. Report on the utility of, and propose a design for, implementing a passive Mode S capability using the proposed Extended Squitter. Create an innovative, cost-effective design for the implementation of Mode S interrogation capabilities.

PHASE II: Refine the design for integration to shipboard IFF systems. Build and demonstrate a prototype system. Address relevant issues associated with performance, production, and manufacturing.

PHASE III: Transition the prototype system into a Navy and/or other DoD / commercial production program.

COMMERCIAL POTENTIAL: The results of this innovative research can be used by all DoD agencies for enhanced situational awareness. Commercially, this system may be used by international civilian authorities for air traffic management.

REFERENCES:
1. Stevens, Michael C., ASecondary Surveillance Radar, Artech House, Inc., 1988
2. International Standards and Recommended Practices, Aeronautical Telecommunications ANNEX 10, Amendment 71, March 1996

KEY WORDS: IFF; Mode S; Air Traffic Control; combat identification; situational awareness; noncombatants.

N99-069 TITLE: Aircraft Optical Cable Plant (OCP)

OBJECTIVE: Current aircraft utilize mostly copper wire for interconnecting avionics systems. First generation optical interconnects were patterned after copper cabling and use MIL-STD 5088 wiring and MIL-STD38999 connectors. . The currently utilized fiber optic interconnect hardware represents an extension or duplication of existing aircraft electrical cabling and connector technology to fiber optic media. A new generation of hardware is being developed commercially based on ribbon cables, array connectors, planar couplers and related repair and installation tools. It is therefore desirable to develop an advanced high density interconnect system based on emerging technology concepts so that avionics interconnect systems can accommodate growth as the technology matures. This high density interconnect will represent a revolutionary advance in interconnect systems based on optical fiber's unique performance characteristics. The vision is to attain a Amobile vehicle information distribution system analogous to the Apremises distribution systems provided for commercial buildings where all elements of a fiber optic interconnect are designed for compatibility, interchangeability and affordability.

DESCRIPTION: An optical cable plant is an integrated system which provides and supports the physical medium for optical data and control communication in aerospace vehicles. The intent of this program is to take advantage of recent commercial developments in materials, components and manufacturing methods to develop a rugged fiber optic cable plant optimized for aerospace and shipboard applications which can accommodate a variety of optical fiber waveguide types. These waveguide types include single mode and multimode glass/glass fibers and waveguides, plastic clad silica fibers and waveguides, and all plastic fibers and waveguides. This second generation cable plant should represent a dramatic improvement over first generation. The ribbon cable should be extremely robust eliminating any concerns over cable damage or fiber breakage in an aerospace environment. Teaming with component developers is encouraged.

PHASE I:The contractor shall provide a design for an OCP consisting of cables and harnesses, connectors, splices, break-out boxes, backplane interfaces, fiber optic couplers, and include test and maintenance concepts for these items. All materials and cable construction shall be identified to provide operation over aerospace environments. Manufacturing, installation and repair tools, processes and training programs shall be identified. The ribbon format should provide for both redundant serial data transmission or parallel data transfer by providing a scaleable fiber count. Connectors, 180 should be designed to provide an extremely small footprint, with low mass connector shells and array inserts, and accommodate both single and multimode fibers. Cable-to-cable connectors, rack and panel connectors and card edge connectors with various angles shall be included in the design. Fiber spacing and cladding diameter should be standardized and hermetic coatings utilized to guarantee long term reliability. The cable connector interface shall be optimized to preclude damage during installation and/or maintenance actions as well as ease of termination. All elements of the cable plant should be compatible including splices and couplers with minimum weight, volume and footprint. This optimized cable plant, when coupled with electro-optic transceivers, shall serve as the physical layer of an integrated information distribution system capable of transferring all information on military and commercial aircraft with dramatic improvements in affordability, reliability, fault tolerance, EMI/EMP immunity and safety. Utilization of this cable plant will improve aircraft performance and fuel economy, providing operational cost effectiveness while reducing new aircraft certification costs.

PHASE II: A flight-worthy prototype OCP will be assembled, tested, and delivered to the Navy for installation in fixed and rotary wing military. The compatibility and interchangeability of all cable plant elements will be demonstrated. In addition, installation and repair tools and methods will be defined and demonstrated. All cable, connector and coupler variants shall be delivered as part of the OCP

PHASE III: The cable plant shall be integrated with selected sub-systems to demonstrate installation procedures, in-flight performance and maintenance actions .

COMMERCIAL POTENTIAL:

The products from this SBIR will be shown to have great commercial potential in general aviation market because of their light-weight, low-cost, and high-speed transmission of data.

REFERENCES: SAE Aerospace Resoure Document DRAFT ARD 5271

KEY WORDS: Optical fiber, ribbon cables, array connectors, optical interconnects, planar couplers, flight control system, avionics,

N99-070 TITLE: Space Time Adaptive Processing (STAP) for an Electronically Scanned Circular Array

OBJECTIVE: Develop space-time adaptive processing algorithms to mitigate the effects on target detection due to electronic counter-measures and ground clutter, for use with the U.S. Navy's UHF Electronically Scanned Array (UESA) Advanced Technology Demonstration (ATD).

DESCRIPTION: The RSTER radar system, located at the Pacific Missile Range Facility on the island of Kauai, is being upgraded to serve as a host radar for the U.S. Navy's UESA ATD. RSTER's existing STAP algorithms support a linear array and must be rewritten to work with a ring array. The new STAP should provide maximum immunity against ground/sea clutter and jamming while working within the constraints imposed by expected 2005 computer performance.

PHASE I: Exploratory research effort to understand and characterize the differences between signal processing for linear and circular (ring) apertures

PHASE II: Selection of optimal STAP taxonomy

PHASE III: Algorithm development and insertion in RSTER

COMMERCIAL POTENTIAL: This same technology could be used to enhance reception for circular arrays incorporated into commercial GPS and communications applications.

REFERENCES:
1. Ward, James. 1994. *Space-Time Adaptive Processing for Airborne Radar*. MIT/LL
2. Zatman, Michael. 1998. *Circular Array STAP,* submitted to IEEE Radar Conference

KEY WORDS: Space-time adaptive processing, radar, circular array

N99-071 TITLE: Compact, Low-Cost, Diode Power Supply for Lasers

SCIENCE/TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop a compact, low-cost, power supply required to drive diode bars for pumping advanced laser materials.
DESCRIPTION: The Navy is investing in LADAR and LIDAR technology for many applications, from terrain LADAR, automatic target recognition (ATR) LADAR, and terminal guidance for missile systems to handheld BC detection LIDAR. For all of these applications, a compact, low-cost laser system is paramount in meeting the application objectives. Other programs are developing the cost-reduction technology to get the cost down on the laser head, but the power supply is currently not being addressed. The power supply, cooling system, and laser head will have to be compatible with missile environments and applications.

PHASE I: Develop a breadboard diode power supply capable of driving lasers used for missile applications. The volume of the power supply shall be < 8 cubic inches. The power output requirements are for a continuous-wave (CW) operation supply with an output of 50W/diode bar with minimum of 2 bars driven. (This could increase and provisions in the design shall accommodate up to 4 bars.) The power supply should support the complete operation of the laser. This could include the operation of a Q-switch and cooling of the diodes (~20W/bar). The PRF should be in the tens of KHz, with a goal of 20 to 30 KHz. Appropriate cooling, if required, should support a continuous run time of up to two hours at full power. The design should be compatible, with application to missile primary power, either 5 Vdc or 28 Vdc. Voltage will be determined at a later time.

PHASE II: Develop a preproduction prototype diode power supply for delivery to the Government for evaluation. This supply will be packaged to be integrated with a Government-owned laser head to provide a laser system for field/flight testing. Compatibility with specific missile applications will be determined during Phase II.

PHASE III: License to manufacturer or set up for commercial manufacturing.

COMMERCIAL POTENTIAL: This power supply could find applications in laser diode drivers for large area displays, communication systems, and medical applications of lasers.

KEY WORDS: Diode Power Supply; Laser; LIDAR; Compact; Low-Cost

N99-072 TITLE: W-Band Short-Pulse IMPATT Diode Development

SCIENCE/TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop a low-cost, highly-reliable, short-pulse IMPATT diode capable of generating 40-50 W of peak RF output power from a discrete device operating at the W-band (75-110 GHz).

DESCRIPTION: The Navy has requirements for high-power, short-pulse, millimeter-wave IMPact Avalanche Transit Time (IMPATT) diodes. There is a foreign source (French) of high powered IMPATT diodes but a domestic U.S. source is desired. Currently the only IMPATT diodes available in the U.S. do not produce 40-50 Watts. Additionally, since they are no longer in active production, the existing devices have to be specially re-packed and have a suspect yield rate. Finally, the existing low power IMPATT diodes are based on 20 year old technology. More recent experimental[1] and theoretical[2] data indicate that 40-50 Watt diodes at 0.5% duty-cycle are producable. Given the advances of technology over the last twenty years it is expected that a new IMPATT diode can be designed which will be technically compliant, low cost and highly reliable such that overall Total Ownership Costs of Navy weapons systems can be reduced without sacrificing performance. A domestic vendor of such a device is greatly desired.

PHASE I: The Contractor will conduct an investigation of IMPATT diode materials, structures, create models, and run computer simulations which predict RF power output and impedance. The contractor must clearly identify the material growth and processing, packaging, impedance matching, and bias modulator technology to be used for the phase II effort.

PHASE II: Conduct material growth, characterization, packaging, and large signal RF testing to achieve 40-50 Watts peak, 0.5% duty-cycle single packaged device.

PHASE III: Produce environmentally qualified, low cost, high power IMPATT diodes for insertion into the Navy program.

COMMERCIAL POTENTIAL: Atmospheric weather radar, communication systems, proximity sensors, collision avoidance radar systems, police radar and automatic RF identification systems.

REFERENCES:

1) W.Behr and J. F. Luy, AHigh-Power Operation Mode of Pulsed IMPATT Diodes, IEEE Electron Device Letters, vol. 11 no. 5, pp. 206-208, 1990

2) P.A. Rolland, C. Dalle, and M.R. Friscourt, APhysical Understanding and Optimum Design of High Power Millimeter-Wave Pulsed IMPATT Diodes, IEEE Electron Device Letters, vol. 12, no. 5, pp. 221-223, 1990

KEY WORDS: millimeter-wave, radar, power, solid-state, IMPATT

N99-073 TITLE: High Power Solid State Components

OBJECTIVE: Develop solid state components for use with high power Silicon-Carbide based transmit modules

DESCRIPTION: Solid state components capable of handling unusually high power loads are needed for integration into the RSTER radar system, located in the Hawaiian islands on the island of Kauai. The system is being upgraded to act as host radar for the U.S. Navy’s FY00 UHF Electronically Scanned Array ATD and subsequent Theater Air Missile Defense Focus Area demonstrations. As part of the upgrade, a switch network must be developed to support the power production capacity of the new Silicon-Carbide based transmitter architecture. Preliminary system architecture analysis indicates that the switches and phase shifters, as well as other components, may not be able to handle the up to ten kilowatt output.

PHASE I: Exploratory research effort to determine the feasibility of a developing an affordable solid state RF and switching components capable of handling up to 10 Kwatts peak power to support the Navy's UHF-band Electronically-Scanned Array (UESA) antenna development ATD.

PHASE II: Design and prototyping of the high power switches.

PHASE III: Manufacture of the switch and integration into a commutation matrix for the RSTER testbed radar.

COMMERCIAL POTENTIAL: The advent of Silicon Carbide-based transistors capable of generating in excess of two kilowatts of power will make possible cellular communication of unprecedented range and fidelity. High power solid state components will be needed to match the power production capacity of these new transistors.

KEY WORDS: Radar, ESA, Switches, switch network

NAVAL SEA SYSTEMS COMMAND

N99-074 TITLE: Submarine Outboard Electrical Cable Connector Improvements

SCIENCE TECHNOLOGY AREA: Material, Process & Structures

OBJECTIVE: Develop and demonstrate innovative electrical connector assemblies which resolve currently observed failures and deficienceis of Submarine outboard cable systems. Based on the disruptive maintenance and cost burden this item places on the Fleet, the Type Commander has placed this item on his Top Management Attention (TMA) list.

DESCRIPTION: Outboard waterborne cables are failing across many submarine CWS and HM&E systems. Outboard systems affected include Vertical Launch System (VLS), Sonar (all types), Towed Array, Masts and Antennas, Bow Planes, 6' countermeasures, anchor light, Secondary Propulsion Motors and connector pin configurations and sizes including 3 to 85 pins. NAVSEA plans to mangage a technical development and testing program that initially identifies the outboard cable connector problems and then determine common solution to all outboard cable connector problems. Note, lessons learned and resources need to be shared across submarine and other Navy programs.

Submarine outboard cabling systems are exposed to mechanical and physical damage, temperature variations of -20 to 140EF, must have an expected life of 12 years minimum, and be capable of grade A shock resistance. In addition, the various innovative design improvements will be exposed to a seawater and salt-air environment and extreme submergence pressures.

PHASE I: Design a connector assembly capable accomplishing the required performance. Survey the available connector assembly schemes that may be capable of being modified and programmed to accomplish the required performance. A review of observed failures and lessons learned from all affected systems is required. Provide recommendations as to which cable connector system(s) are a basis for further development and prototype, and apply trade-offs based on key attributes. Develop a detailed plan to convert requirements into a prototype system. The survey and plan should include technical, cost and schedule estiamtes and associated risks.

PHASE II: Based on survey results and plan recommendation in Phase I, design, develop or modify, as required, and test specific improvements to various outboard cable system types.

PHASE III: Fully integrate the successfully demonstrated improved cable assembly types. Liaison with the SBIR POC for land-based verification and validation and eventual at-sea testing.

COMMERCIAL POTENTIAL: Application to the design and development of new marine vehicle or structure electrical systems exposed to a liquid or spray environment. In addition, the improved cable assembly features will be highly beneficial to all applications which depend on reliable electrical cable integrity and the proper mating of electrical connectors including Aerospace, Communications, computer applications, etc.

REFERENCES: (available at Defense Technical Information Center)

NAVSEA Molding Manual

Weapons Delivery System Equipment Manual (WDSEM Vol V)

Application Affected System Drawings

Ship Specifications for Deep Diving Submarines

KEY WORDS: Electrical Connector; Cable Assembly; Molding Practices; Outboard Cables; Mating; Training

N99-075 TITLE: Advanced Submarine Coatings

OBJECTIVE: Investigate new approaches to submarine coatings that have less compressibility (reduce ship design impact) while providing equal or better performance in signature reduction when compared to currently used coatings.

DESCRIPTION: The current family of voided urethane materials used for submarine external hull coatings has limited potential for future stealth performance gains without excessively impacting the overall ship design and performance. To meet challenging future stealth goals, new approaches and concepts need to be developed. Examples might include non-homogenous materials or tuned passive resonance materials. Concepts must be compatible with the sea water environment and durable enough for external submarine application. External coatings are used in combination with other signature reduction strategies. More effective coatings will result in less need for other treatments and attendant cost savings.

PHASE I: Develop innovative, stealthy submarine coatings meeting the objective(s) of this Topic. Select a concept and perform preliminary investigations to determine anticipated performance and address feasibility for installation on submarines.

PHASE II: Build samples of the coating concept and conduct testing to validate performance.

PHASE III: Shipyards and Navy laboratories will participate with the small business concept developer to investigate large scale material fabrication, submarine application, material and process specifications, and optimal coating design using the new concept.

COMMERCIAL POTENTIAL: Products developed under this topic have performance aspects in common with coatings used in the transportation industry to meet acoustic, structural, and corrosion needs. In addition to the products themselves, there is a potential to share related analysis and modeling capabilities between industry and government.

KEY WORDS: Coatings; materials; submarine; external; stealth;

N99-076 TITLE: Non-Destructive Testing (NDT) Method for Locating and Plotting Flaws in Elastomer Components

OBJECTIVE: Develop a method to determine the size, orientation, and location of flaws found in elastomer components.

DESCRIPTION: The technology to accumulate and store significant levels of strain energy in an elastomer has been demonstrated by the inflation of large (8' diameter, 10" thick) disks, spheres, etc. The need to accurately locate small flaws (1/8" x 1") introduced during fabrication below the surface of the elastomer part is critical to the safety, operational performance, proof testing, and quality assurance of such parts. This effort would use the innovative implementation of existing and new technology to design and fabricate a suitable sensor system for the above application.

Existing methods used for NDT include low frequency ultrasonics, xerography, tomography, and fluoroscopy. Ultrasonic methods are well suited for measuring the thickness of a rubber part, but have difficulty in conveying the orientation, overall size, and type of the flaw. X-Ray methods such as xerography and fluoroscopy have been used to locate flaws, but their accuracy is susceptible to the orientation of the flaw with respect to the X-Ray beam.

PHASE I: Develop innovative concept design(s) and a breadboard demonstration in sufficient detail to assess performance and cost of a manufactured device.

PHASE II: Fabricate prototype device and conduct in-situ evaluations with actual or elastomer components. Optimize performance and accuracy while maximizing repeatability.

PHASE III: Manufacture production device packages including operating instructions and specifications. Sell devises to Navy and/or manufacturer of Elastomeric Ejection System components, or other highly strained elastomeric components, for production quality control, product acceptance tests, and in-service quality inspection.

COMMERCIAL POTENTIAL: The use of elastomers and rubber materials in industry and consumer products is ubiquitous. Flaw locating and plotting capabilities will not be limited to highly strained disks and spheres. This technique will enable manufactures to routinely inspect prototypes during product development as well as production and in service hardware.

REFERENCES:

1. Halsey, G.H., Nondestructive Testing, Rubber Age, February, 1968.
2. Dodge, D.D., Principles and Applications of Non-destructive Testing, American Society of Mechanical Engineers, Paper No. 61-WA-323, 1961.

KEYWORDS: Non Destructive Testing; NDT; sensor; elastomer; transducer; rubber

N99-077 TITLE: Open Architecture, Windows/MFC Engineering Geometry System Generator Encapsulating GOBS/ DT_NURBS (GeometryObject Server (GOBS) initiative, with its underlying David Taylor Non Uniform Rational Basis Spline)

OBJECTIVE: Create a geometry kernel, utilizing the advanced engineering features of the GOBS/DT_NURBS geometry representations, within a software development environment widely applicable to design and analysis codes for naval ships; provide for an order of magnitude increase in productivity and decrease in cost for development of geometry related software codes.

DESCRIPTION: Past experience with existing CAD (Computer Aided Design) systems and solid modeling kernels has highlighted the need for broad access to open, common representations to support naval ship design and simulation efforts. The Geometry Object Server (GOBS) initiative, with its underlying David Taylor Non Uniform Rational Basis Spline (DTNURBS) representation, is proving effective in provision of a common geometry representation for this purpose. In addition, Windows NT/95/98 based software products have become an accepted part of many activities in NAVSEA, including naval engineering efforts. In the near future, most young engineers will have been trained on Windows based systems, which they have used in school and at home. Although full scale engineering development efforts will generally remain UNIX based, the low cost of PC equipment, combined with the availability of Windows knowledgeable engineers, suggests that provision of a Windows / GOBS / DT_NURBS development environment will enable the Navy to leverage the effectiveness of both technologies in a wide range of smaller scale applications and simulations.

Experience with existing systems has also suggested that no single CAD system or geometry library (e.g., ACIS, Parasolid) will provide cost effective solutions to the problems presented in naval ship design. For example, an expensive, full size CAD package might be used to determine a volume that can be calculated using a very small number of API (application programming interface) calls into the CAD systemís kernel. However, because access at such levels is so complex - a programmer is always required - it is not currently practical to provide the much more compact and simpler programs that should be possible in theory. The goal of this SBIR is to explore the feasibility of a GOBS/DT_NURBS geometry interface generator utilizing MFC (Microsoft Foundation Classes) and augmented Visual C++ Application Wizard technology or some alternate technology. The generator system should enable an engineer to specify the design of their interface into GOBS in high level terms, and the system should generate open, MFC compatible C++ code. The generation of ActiveX control code for incorporation into derived Visual Basic applications should be considered.

PHASE I: Research the current GOBS/DT_NURBS system. Identify, research and design: i) a small but composable set of editing operations defined over GOBS; and, ii) a small but composable set of user interface mechanisms. Using augmented Application Wizard technology or an alternate proposed technology, demonstrate the generation of simple editing interfaces into GOBS as determined by high level specifications.

PHASE II: The design concept developed during Phase I should be scaled up to support generation of useable GOBS interfaces through an alpha version of the generator. This work should include extensions to the editing operations, user interface mechanisms and generator mechanisms. Issues associated with the representation of high level specifications for this purpose should be explored in depth. A problem involving early stage naval ship design should be identified, researched, and used as a test case.

PHASE III: The phase II system will be refined to produce a beta software version, and that version will be used in the creation of a family of GOBS based applications involving early stage naval ship design and analysis.

COMMERCIAL POTENTIAL: By decreasing the time and complexity of generating editing interfaces into GOBS / DT_NURBS, the proposed technology could stimulate the growth of both developers and users of that evolving geometry kernel. As a result, more modern, robust, lower development cost alternates to existing solid modeling core technology should become available.

REFERENCES:

1) DT_NURBS User Manual, Reference Manual, Theory Manual. http://dtnet33-199.dt.navy.mil/DT_NURBS/doc.htm.
2) Microsoft Visual C++ on line documentation.

KEY WORDS: DT_NURBS, GOBS, Naval Ship Design, CAD, Program Generators, Software Development

N99-078 TITLE: Testability and Certification of Complex Software in Total Ship Computer Environments

SCIENCE/TECHNOLOGY AREA: Software

OBJECTIVE: The objective of this topic is to develop technologies to address the testability and certification of complex software-intensive application/systems within a total ship computing environment. The testability and certification must be supported in an environment where software tasks may be dynamically allocated across the computer resources. Of particular concern is the ability to test/certify functionality, real-time response, and availability factors.

DESCRIPTION: Computer system plant, such as the one envisioned for the next generation surface combatant, DD21, will provide support for the breadth of computational needs within the ship. System applications will provide the software, actuators and sensors, while the ship will provide the computational resources. The challenge is to provide sufficient confidence in testing and certification that the application’s functionality will be provided with sufficient quality and predictability. Complicating matters is the increased usage of commercial off the shelf (COTS) products and emerging computer technologies enabling dynamic allocation of software application task within the environment. Both these factors further stress current testing and certification approaches. New and innovative approaches are needed.

PHASE I: Develop new and innovative methodologies to test and certify computer software-intensive systems. Provide notional example of how methodology might be applied to a complex ship environment.

PHASE II: Refine methodology and implement associated software support and process enablers. Apply prototype testing system to a portion of total ship computing environment to demonstrate initial feasibility.

PHASE III: Transition integrated approach to ongoing DoD complex software-intensive applications including naval ship application programs. Commercialize approach to increase quality of commercial-based systems.

COMMERCIAL POTENTIAL: Testability and the ability to ensure sufficient quality of software-intensive systems continues to be an important area in the commercial community. The Internet community, companies' enterprise networks, and the telecommunications industries all have a critical need for increased ability to test and verify systems. Financial and commercial avionics/transportation-based systems especially require a high level of confidence.

KEY WORDS: Test, Certification, Software, Shipboard, Networks, Computers

N99-079 TITLE: Multi-Level Security in Advanced Computer-Intensive Environments

SCIENCE/TECHNOLOGY AREA: Computer/software

OBJECTIVE: The objective of this topic is to develop technologies to address the multi-level security within a complex software-intensive system environment. Of particular concern is the ability to maintain multi-level security while support robust ability to migrate and reallocate software task through a complex computer network architecture.

DESCRIPTION: Computer system plant, such as the one envisioned for the next generation surface combatant, DD21, will provide support for the breadth of computational needs within the ship. Advanced operating systems, resource management systems, and message middleware is facilitating the ability to quickly reconfigure software and hardware components to react to changing mission (needs), faults to software or hardware, and changing resource requirements. The dynamic nature tends to be counter to the approaches to support multi-level security; however, information within such a complex environment will include multiple levels of security classification, with varying need to know by operators and crew members. This will be especially critical as crew sizes decrease in new ship classes. The intended approaches would leverage current multi-level security technology, evolving where possible, redesigning when needed.

PHASE I: Design and develop concepts for multi-level security approaches which will be fully operative in the future total ship computer environments. Investigate system solution, including hardware, software and processes necessary to implement conceptually design.

PHASE II: Continue to refine and prototype the conceptual approach. Perform trade-off studies of competing designs. Implement prototype system and demonstrate initial feasibility.

PHASE III: Integrate approach into emerging computer system architectures and demonstrations of advanced shipboard computer environments. Begin production to wider commercial audience.

COMMERCIAL POTENTIAL: Multi-level security is becoming a real concern within the telecommunications, banking, and internet commerce. Technologies developed within this effort should be directly commercialized and marketed within these communities. The commercial sector has an immediate need for these capabilities.

REFERENCES:
1. Computer System Security B An Overview: http://www.sei.cmu.edu/str/descriptions/security_body.html
2. DoD Trusted Computer System Evaluation Criteria, DOD5300.28_STD, December 1985, available at http://www.radium.ncsc.mil/tpep/library/rainbow/5200.28-STD.html

KEY WORDS: Security; Computer; Integration; Network; Shipboard; Resource Management

N99-080 TITLE: Affordable Wideband Radar Receiver

SCIENCE/TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: To design, develop and demonstrate an active phased-array radar receiver utilizing true time delay beamforming technology. The concept must be scalable to large antennas with 10,000 or more elements, maximally leverage currently available Commercial of the Shelf (COTS) technology and entail affordable insertion and life-cycle support costs.

DESCRIPTION: Future naval combat systems will include phased-array radars with wide instantaneous bandwidth for high range resolution, target detection and discrimination functions. However, such functions cannot be supported by presently employed beamsteering techniques (e.g. frequency scanning and electronic phase-shift steering). A minimum ten-fold increase in bandwidth can be achieved by implementing true time delay (TTD) beamsteering. However TTD demonstrations to date have not demonstrated scalability to large systems. The following technical objectives should be incorporated in a TTD-steered phased array receiver:

Active array dimensions at least 1 x 64 elements; +/- 65 degree scan angle; 4 dB noise figure; 70 dB-MHz dynamic range; Minimum time delay resolution of 1ps; 1 micro second reconfiguration time; Extremely high phase stability; Scalability to large arrays

PHASE I: Develop and evaluate receiver concepts on the basis of both performance and cost, considering application to the 64 element (minimum) PHASE II array and a hypothetical 10,000 element array. A laboratory demonstration is desired. From evaluation results, prepare specifications and acceptance test procedures for components for proposed active array.

PHASE II: Procure and test components for compliance with established specifications and assemble components into prototype beamformer. Package beamformer for insertion into a test vehicle. Perform near and far field testing of receiver. Provide simulated radar returns to evaluate receiver performance in hostile and/or cluttered environments.

PHASE III: Full development of wideband microwave transmitter/receivers for military and commercial applications.

COMMERCIAL POTENTIAL: Wideband phased arrays are increasingly used in commercial satellite/wireless communication systems. Analog receiver technology developed for this SBIR topic could be easily adopted to such digital commercial applications.

REFERENCES:
1. R.J. Mailloux, Phased Array Antenna Handbook, (Artech House, Boston, 1994) pp. 34.
2. Zmuda, H., and Toughlian, E.N. (eds.), Photonic Aspects of Modern Radar, (Artech House, Boston 1994)

KEY WORDS: Radar; beamformer; receiver; antenna; beamsteering; wideband

N99-081 TITLE: High Speed 2x2 Optical Switches

SCIENCE/TECHNOLOGY AREA:: Electronics

OBJECTIVE: Develop a compact 2x2 optical switch suited for fiber optic microwave distribution applications.

DESCRIPTION: Optical switches are needed for wide instantaneous bandwidth radars. Current optical switches cannot simultaneously meet all anticipated performance requirements. The proposed 2x2 optical switch should have low (1 dB) insertion loss, sub-microsecond switching time, >55 dB return loss, and >55 dB optical extinction, and good temporal and temperature stability.

PHASE I: Develop and evaluate a compact, high speed, high optical power switch. The device must respond to sub-microsecond control signals and be appropriately packaged. A hardware demonstration is desired.

PHASE II: Develop, test and demonstrate the proposed optical switches.

PHASE III: Full development for commercial, military and university research applications is envisioned.

COMMERCIAL POTENTIAL: This optical switch would be of great benefit to commercial industries involved in analog optical communication systems, such as millimeterwave fiber-optic feeds for indoor wireless and also satellite-based phased array antenna development.

REFERENCES: Zmuda, H., and Toughlian, E.N. (eds.), Photonic Aspects of Modern Radar, (Artech House, Boston 1994)

KEY WORDS: optical switch; microwave distribution; high speed;high isolation;high extinction;analog transmission

N99-082 TITLE: Assessment of Reduced Manning Impacts on Ship Crew Operational Effectiveness and Computer Resource Requirements

SCIENCE/TECHNOLOGY AREA: Manpower, personnel, and training

OBJECTIVE: Develop a capability which will enable commanders, evaluators, and mission planners in real time to determine the impact of reduced manning availability on human error potential, crew workload, total ship computational workload and operational performance effectiveness for selected mission scenarios.

DESCRIPTION: The Navy is faced with two challenges in the operation of existing and future surface ships. First, human error continues to represent the major threat to safe ship operation, accounting for about 80% of Navy ship accidents. Second, future Navy ships will be manned with significantly fewer crew members than existing ships. With Smart Ship, existing ships will also be re-designed and reconfigured for manpower reductions. A major concern in the acquisition of reduced manning ships, or in the reduction of manning in existing ships, is that ship personnel maintain required levels of operational effectiveness across all projected missions and mission conditions. This includes the assurance that the fewer personnel manning Navy ships will be fully capable of performing required tasks in normal and emergency conditions, and will commit fewer errors and cause fewer accidents as compared to present day ships. To ensure that operational effectiveness is not compromised in a reduced manning environment, advanced technologies will be employed to assess performance capabilities, the potential for human error, crew workloads, and impacts of the total ship computer resources for specified mission scenarios in reduced manning conditions. Capabilities addressed in this topic will include: play out what-if analysis to assess the impact of mission scenarios on ship, system, computer plant requirements, and personnel capabilities, including human error potential, crew workloads in an operational, reduced manning environment; support real-time mission planning exercises where the emphasis is on ensuring that available resources, including manpower and computer resources, are most effectively employed and deployed for specified missions; provide real-time manpower planning during periods of conflict where crew incapacitation or system degradation will further impact crew workloads and workload distributions; support determination of the impact of proposed modifications to existing or projected ship systems on personnel performance capabilities, error potential, computational workload and crew workloads. The elements of the capability will include an interactive task network simulation capable of analyzing missions over all phases of a ship's operational cycle (combat, training, in-port) and defining mission outcomes and human performance capabilities and workloads for selected mission scenarios; a scenario generator capable of modifying subroutines and process variables associated with standard mission scenarios to achieve a set of tailored scenarios which address the problem at hand; algorithms, process variables and subroutines for estimating the probability of human error, and determining the impact of specific errors on operational effectiveness; and a highly usable display capability which will readily support the effective configuration of scenarios, and present a meaningful display of parameters at selected time points or events in the scenario, understandable by operational commanders, evaluators, and planners with little or no formal training in the implementation technologies employed.

PHASE I: 1) identify and describe specific applications and develop concepts for manning assessment within those applications; 2) develop and produce a set of functional requirements for each application, including user activities and decisions, and program information, performance, decision, support, and interface requirements; 3) develop and produce a functional specification for the analysis capability, and 4) develop and produce prototype display screens for specific applications.

PHASE II: Produce the analysis software, procedures, standard scenarios, heuristics for tailoring the scenarios, and display generation capabilities needed to meet the need, and will demonstrate and evaluate the developed capability to determine performance and workload impacts of mission scenarios, and the capability to simulate the user quickly and accurately.

PHASE III: Apply the developed capability to advanced ship acquisition programs including DD 21, LPD-17, and MFSS Demonstrator, and will acquire data on the capabilities and limitations of the operational simulation for specified applications. The capability will also be applied to existing ships, including Smart Ship, Gator 17, Smart AOE, Smart Base, DDG-51, and CVNs.

COMMERCIAL POTENTIAL: The capability will have direct application to the problem of maintaining operational effectiveness of a complex system after downsizing, and will be especially useful to commercial enterprises facing the same performance constraints as the surface Navy, and where human performance is critical to safe and effective system operation. Examples of potential commercial users of the modeling and simulation include commercial ship owners and operators, the off shore petroleum industry, chemical process control systems, and nuclear power plants.

REFERENCES:

1. Bea, Robert G. (1994) The Role of Human Error in Design, Construction, and Reliability of Marine Structures, U.S. Coast Guard Ship Structure Committee.
2. Malone, T.B., Baker, C.C., Anderson, D.A., Bost, J.R., McCafferty ,Jennings, M., Noreager, J., and Terry, E., (1996) Human Error Reduction through Human and Organizational Factors in Design and Engineering of Offshore Systems, 1996 International Workshop on Reduction of Human Error through the Application of Human and Organizational Factors in Design and Engineering, New Orleans, LA., December, 1996.

KEY WORDS: Human error; reduced manning; human workload; total ship computational workload; operational performance effectiveness; crew workload

N99-083 TITLE: Multi-Disciplinary and Multi-Sensor Integrated Display Development

SCIENCE/TECHNOLOGY AREA: Sensors, Software Computing

OBJECTIVE: Develop new display formats that facilitate multi-disciplinary and multi-sensor presentation of data on reduced manpower 21st century surface combatants.

DESCRIPTION: Proposed manpower limitations on the new surface combatants will require the use of innovative combat system display techniques. Operators from multiple disciplines will be required to use a common set of displays that will present multi-sensor data throughout the ship. These displays must present an integrated picture of multiple sensor data including (but not limited to) active sonar data, electronic warfare data, radar data, and passive sonar contacts. A common display concept is vital to the multi-disciplinary aspect of this system. Interfaces to the various sensor systems are necessary to include their data on a common set of displays. The displays should give the operator access to data, not only contacts, without requiring the operator to drill down into unfamiliar display systems; The displays should be capable of presenting data and contacts in an effective and efficient manner. Consideration should be given to the ability to overlay multiple data types (at the contact or data level) effectively, and the presentation of logical guides to orient the operator to the scenario quickly. Development of automation type tools to help operators manage and follow multiple data types on the display is vital.

PHASE I: Formulate a display design concept, including basic formats, operator-machine interface philosophy, data connectivity, and data integration concept.

PHASE II: Prototype the proposed display concepts on a commercial workstation, using simulated data and stored sensor data. Include sufficient functionality to clearly demonstrate the integration of data presentation from multiple sensor systems, and demonstrate operability.

PHASE III: Implement fully the proposed multi-sensor display system in a combat system test-bed or development facility, including connectivity to real data from multiple sensors. Demonstrate the data integration and operability features in a realistic environment of real time multi-sensor data inputs.

COMMERCIAL POTENTIAL: The data fusion and multi-disciplinary display concepts developed under this topics may be useful in many areas where human operators are required to perform complex simultaneous tasks based on multiple real time data inputs. Examples include air traffic control, stock/commodity trading, aircraft piloting, and police dispatching.

REFERENCES: Tufte, Edward R., The Visual Display of Quantitative Information, Graphics Press, Chesire CT, 1983.

KEY WORDS: Display; Computers; Operator-machine interface; OMI; Combat system; Sensor data

N99-084 TITLE: Adaptive Mainbeam Cancellation Technique

SCIENCE/TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: The objective of this proposal is to develop a practical, affordable, technique to achieve effective cancellation of narrow, or wideband, jamming interference in the mainbeam regions of solid state, active aperture radars, while retaining significant capability for detection and angle measurement.

DESCRIPTION: Antenna based electronic counter counter measures (ECCM) techniques are far more robust in the sidelobe region than in the main beam. Low design sidelobe levels simultaneously provide for substantial innate rejection margins, and for simpler architectural requirements for implementation of adaptive cancellation systems. In contrast to the above, mainbeam jamming enters the receiver largely unattenuated, and requires expensive, full gain, auxiliary patterns, to cancel adequately. In addition, after such cancellations are effected, the mainbeam patterns are likely to become sufficiently distorted, to seriously degrade both detection sensitivities, and angle measurement capabilities. Since radar trends indicate ever-increasing sensitivity requirements, the deleterious effects of electronic counter measures (ECM) will also increase, in direct correspondence, unless adequate countermeasures are provided for in the original designs. Front end countermeasure solutions are to be thought of as integral parts of future active array architectural designs.

PHASE I: Develop one, or more, innovative techniques to effect practical, operationally meaningful, mainbeam jamming cancellation in solid state, active array, radar architectures. Develop the attendant architectural requirements, and analyze the detection and angle measurement performance via a computer simulation, against both narrow and wideband jammers. Use the results to demonstrate the feasibility and practicality of such solutions.

PHASE II: Demonstrate and validate these techniques using an existing active phase array, in an existing test bed. The array can be an operational array, or a prototype under development.

PHASE III: Insert this new technology into one, or more, active array programs within the Navy community, or within another branch of the U.S. military.

COMMERCIAL APPLICATIONS: The technology developed within this project can become an integral part of many future solid-state-active-array radar designs within the commercial community. These can involve a variety of applications, i.e. shipboard, airborne and ground based radars. The technology is also applicable to reducing interference on satellite systems and digital cellular base stations.

KEY WORDS: adaptive processing; mainbeam cancellation; jamming; active aperture; radar; electronic counter measure

N99-085 TITLE: Space Time Adaptive Processing for Advanced Phased Array Radar Systems

SCIENCE/TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: Demonstrate improved performance of advanced phased array radars for shipborne applications by implementing Space Time Adaptive Processing (SRAP) Techniques. Demonstrate that similar techniques can be applied to commercial systems such as imaging radars, communications systems (e.g. satellite and cell phones), and to satellite navigation systems.

DESCRIPTION: With the maturing of phased array and radar processing technologies, Solid State Active Array (SSAA) radars can be expected to play an increasingly larger role in advanced radar systems. SSAA radars can provide significantly greater performance. For example, they can dynamically position multiple antenna beams to steer around mainlobe jammers, allocate a higher percentage of the dwell time on high priority sectors, and dwell on selected high priority (threat) targets for extended periods of time. STAP has been identified as a key technology that can optimize the sidelobe levels in an SSAA to minimize clutter and jammer returns, and thus provide improved detection performance of small targets in the presence of severe clutter from littoral environments and jamming. STAP techniques can also be used to reduce the clutter spread due to ship motion and to cancel advanced jamming signals such as mainlobe scattered interference (MSI). STAP refers to the extension of standard adaptive antenna techniques to processors that simultaneously combine signals received on multiple elements of an array (the spatial domain) and multiple pulse repetition periods (the temporal domain) of a coherent processing interval. STAP offers the potential to improve radar performance in several areas. First, it provides a robust approach that can simultaneously attenuate interference from multiple sources including jammers (directed and reflected path), friendly interference, clutter, and own shipboard interactions. Second, it offers low and medium pulse repetition frequency (PRF) systems improved low velocity detection through better mainlobe clutter suppression. And third, it offers an adaptive strategy for handling a non-stationary interference background, as is often found in littoral environments.

PHASE I: Develop a STAP technique to improve shipboard SSAA radar performance in clutter and jamming. Provide top level assessment of implementation issues both in the antenna and processor areas.

PHASE II: Perform an in-depth analysis of processor throughput requirements for STAP. Evaluate commercial off the shelf (COTS) processor implementations. Demonstrate the algorithm processing capability with a non-real time COTS demonstration.

PHASE III: Provide a real time COTS processor demonstration of STAP.

COMMERCIAL APPLICATIONS: STAP technology can provide improved performance in clutter and jamming/interference to a wide range of military and commercial radar and communications systems. Ground mapping synthetic aperture radars (SARs) are being developed to perform a host of tasks, including earth resource mapping, crop monitoring and disaster assessment. The cost of re-flying a mission if data is lost due to Radio Frequency Interference (RFI) makes STAP a cost effective solution. Additionally, SARs (operating at UHF and capable of penetrating foliage), are being used to collect important data. These radars are subject to a wide variety of RFI, including radio and television signals. Ground Positioning System (GPS) Systems are needed to provide accurate position and navigation data in critical civilian applications. Air traffic control will require using STAP techniques to reduce both intentional interference and unintentional RFI. Airborne radars, digital cellular base stations and satellite systems are candidates as well. STAP will be extremely valuable in these systems.

KEY WORDS: adaptive processing; phased array; radar; electronic counter measure; jamming; clutter suppression

N99-086 TITLE: Development Of 5 Micron Self Cleaning Fuel Oil Filter

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: To develop a filter, which is rated for 5 micron but also is self cleaning. This self-cleaning feature reduces maintenance manhours on the ship's crew plus significantly reduces the HAZMAT issues.

DESCRIPTION: DFM which is the fuel used on all navy ships has a significant amount of debris in the 5 to 25 micron level. The gas turbines used to power our ships have to have fuel which does not have greater than 10 microns. The filter separators used to condition fuel i.e. Remove debris and water, have passages which are as low as 5 microns. This small passage requirement is needed to assure the separation function is effective. In order to eliminate the need to periodically replace the filter separator elements, a prefilter upstream of the separator unit is needed. Having a self cleaning 5 micron prefilter would reduce material costs, maintenance man hours, reduce hazards associated with having open pressure vessels containing fuel exposed to the personnel and shipboard equipment. The filter should be sized for 135 gpm, at 100 psig, with a debris removal rate of 10-mg/l with particle sizes ranging from 5 to 25 microns.

PHASE I: Develop a proposed concept or scheme for self cleaning removal of particulate material from 5 to 25 MICRON level, inclusive, from Diesel Fuel to demonstrate the feasbility of accomplishing the objective.

PHASE II: Prepare a layout of the design with actual sizing of components plus selective testing of filtering components, and fabricate and demonstrate a prototype.

PHASE III: Construct a full sized unit and perform laboratory testing.upon satisfactory lab tests, install the unit onboard a naval ship for operational testing.

COMMERCIAL POTENTIAL: All commercial ships, petroleum industry, shore side power plants, and processing plants that use fuel or lubricating oils in their operation could benefit from this development.

KEY WORDS: strainers; filters; self-cleaning; 5 microns

N99-087 TITLE: Development of Improved Non-Skid Coating

SCIENCE/TECHNOLOGY AREA: materials and structures

OBJECTIVE: To develop a non-solvent based non-skid that will last longer (including improved jet blast resistance) than the current solvent based non-skid systems. The new non-solvent based non-skid must be able to improve and reduce overall life cycle cost to the Navy. The new non-skid surface must be environmental compliant, wear resistant, corrosion resistant, and a have a coefficient of friction (slip resistance) of a minimum of .90 dry, .85 wet, and .75 oily.

DESCRIPTION: Todays non-skid have very limited life. This SBIR proposes to develop a much longer life non-skid that uses refractory materials. The non-skid shall have metallic or nonmetallic materials combinations thereof which exclude normal paints based materials such as hydrocarbons, silicone, or halide technology and shall withstand the increased exhaust temperatures of 700 degrees F or higher and mass flows associated with future aircraft engines.

PHASE I: Develop a non-skid system, which provides the attributes described above.

PHASE II: Develop/ implement plan to test non-skid system on active navy ship platforms.

PHASE III: Develop appropriate specifications/documentation to make the system standard in the fleet.

COMMERCIAL POTENTIAL: Improved non-skid coatings can be applied in the commercial shipping industry, on drilling platforms, to improve walking surfaces (steps, subway stations, and ramps), and for recreational applications (theme parks, swimming pool decks, tennis courts etc).

KEY WORDS: Non-Skid, Coatings, Flight Decks

N99-088 TITLE: <u>Reliability of Watertight Boundaries</u>

SCIENCE/TECHNOLOGY AREA: Materials and Structures

OBJECTIVE: To assess the structural reliability of the decks and bulkheads forming watertight boundaries of vital spaces and develop structural design criteria that will provide a level of reliability that is consistent with damaged stability criteria.

DESCRIPTION: Structural boundaries of spaces essential for survivability are based on historical practices that do not consider the probability of design loads being exceeded. Certain flooding conditions that would occur after damage to the ship, which could result in loads that could cause structural failure and progressive flooding, causing the loss of the ship. The reliability of these structural boundaries (so-called secondary structure) has not been addressed in research efforts to date, but is important for survivability from damage.

PHASE I: Develop a framework for the assessment of the reliability of the structural boundaries of flooded spaces. Identify the tools to be used to compute wave heights, ship motions, and the ensuing loads on the structural boundaries. Identify the tools necessary for determining the ultimate strength of the structure and the probability of failure. Demonstrate the approach by evaluating a sample case, using linear approximations as necessary.

PHASE II: Develop the tools identified in PHASE I, and use them to assess the reliability of the structural watertight boundaries of at least three different ship types. Using the results of the analysis, develop a procedure for use in ship structural design that will provide a uniform level of reliability for these structural watertight boundaries.

PHASE III: Improve and document the computer programs developed in PHASE II so structural designers can routinely use them. Use these tools in a ship design environment and demonstrate the improved capability of the ship when designed with the new criteria.

COMMERCIAL POTENTIAL: The computer programs developed will require maintenance to add features that users will identify, including interfaces with other ship design computer programs. With acquisition reform, naval ship designs will be performed by private contractors, and the computer programs will be sold to them. Because the subject of the reliability of flooding boundaries is not addressed in the design of commercial ships, there is a great opportunity for the use of this design procedure for those ships.

REFERENCES:
1. Ship Structure Committee Report SSC 392, Probability-Based Ship Design: Implementation of Design Guidelines
2. Ship Structure Committee Report SSC 398, Assessment of Reliability of Ship Structures

KEY WORDS: Structural reliability; damaged stability; watertight boundaries; bulkheads; decks; flooding.

N99-089 TITLE: <u>An Automated Shipboard Cargo-Handling System</u>

SCIENCE/TECHNOLOGY AREA: Manufacturing

OBJECTIVE: To develop a modular system for automated handling of cargo aboard commissioned Navy and Military Sealift Command ships.

DESCRIPTION: In order to achieve automated cargo handling aboard naval ships, it is proposed that an automated storage and retrieval system (AS/RS) be developed for use in a cargo hold, magazine, and storeroom of a ship. It should be modular, in that the same basic components will fit into large holds/magazines or small storerooms, with only a difference in the number or scale of sections or modules pieced together. The system will receive and deliver a pallet and/or a case to the user on demand, will track the entire inventory within the system, will provide real time status reports, and interface with supply systems on other ships and ashore. Reliability, maintainability, and availability (RMA) factors are critically important to the system. It must be extremely durable for shipboard use and be fully operable in an at-sea environment.

PHASE I: Develop a concept design and prototype the system via Modeling and Simulation to meet the requirements of a designated NAVSEA Technical Point of contact (TPOC). Simulate the design in multiple configurations to show modularity. NAVSEA will select the participating TPOC in order to bound the problem.

PHASE II: Develop and engineering design package of the system within a selected ship. Model sea-environment forces to show that the proposed system is acceptable for shipboard use.

PHASE III : Develop the detail design for the AS/RS system, fabricate a prototype and install it in a testbed aboard ship.

COMMERCIAL POTENTIAL: This system will advance the state-of-the-art in existing AS/RSs by at least one generation in shoreside systems. It will have direct application to the cruise ship industry.

KEY WORDS: Automated cargo handling; AS/RS; pallet storage; palletized cargo; automated warehouse; shipboard automation

N99-090 TITLE: Advanced Monitoring and Diagnostics of Valves and Actuators

SCIENCE AND TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop/investigate Condition Based Maintenance (CBM) technology to predict and reduce impending valve and actuator failures.

DESCRIPTION: Valves and their actuators are the controls for fluid systems. As with other piping components, the health of valves and actuators deteriorate with time. Unexpected failures of a critical valve can shut down vital fluid systems. The nuclear power industry has developed a non-intrusive, condition based maintenance solution to forecast impending failures of automated valves. The technology relies upon use of equipment mounted sensors that will collect the Asignatures of the valves and their actuators in real time, and predict impending failures by providing early warnings. Currently, the equipment for data gathering and interpretation is rather bulky and very expensive for use in non-nuclear applications. This task would develop both hardware and software innovations that will significantly advance the technology resulting in reduced cost and size, and reduced maintenance for valves and actuators on board naval vessels in non-nuclear applications.

PHASE I: Research and develop an affordable condition-based monitoring and diagnostic sensors and system embodying technology improvements to achieve reduced costs and size. Select optimum technology, reduce the size of sensors and related equipment to acceptable shipboard levels, determine data sampling rates, and integrate with the current Navy ICAS system. Both portable as well as on-line mounted equipment will be addressed.

PHASE II: Implement the concepts of Phase I, including the design, development and testing of prototype sensors and systems. Conduct detailed cost analysis of the technology, and its return on investment. Determine all elements of CBM which are necessary to implement the technology on naval shipboard fluid systems.

PHASE III: Aboard Naval ships and in commercial applications the maintenance costs for fluid systems are many times more than the cost of the original equipment. Often, the cost of a plant shut down due to a faulty valve can be in hundreds of thousands of dollars a day. Condition based equipment, which can accurately predict failures, are a near-term requirement, and will be installed and specified as soon as available. As such, US Navy, commercial power plants, chemical process industry, petroleum and refining industry, and others that are big users of automated valves stand to benefit by the successful development of this technology.

COMMERCIAL POTENTIAL: This technology has direct application to commercial ships, power plants, chemical process industry, petroleum and refining industries.

REFERENCES: R.C. Rittenhouse, Valves, Valve Materials and Testing meet tougher demands, Power Engineering, January 1991. William O'Keefe, Power Plant Valves, Power, May 1990. William O'Keefe, Monitoring Valves, Actuator Performance, Power, July 1988. R.C. Rittenhouse, Electronic Data Systems, Plant Engineering Magazine, May 1991 Instrument Society of America, ISA Handbook of Control Valves, 2nd Edition

KEY WORDS: Condition Based Maintenance; Valves; Actuators; Sensors; Electronics Advanced Monitoring, Diagnostics; Signatures

N99-091 TITLE: Non-Destructive Testing (NDT) Method for Locating and Plotting Flaws in Elastomer Components

SCIENCE/TECHNOLOGY AREA: Materials/Processes/Structures

OBJECTIVE: Develop a method to determine the size, orientation, and location of flaws found in elastomer components.

DESCRIPTION: The technology to accumulate and store significant levels of strain energy in an elastomer has been demonstrated by the inflation of large (8" diameter, 10 thick) disks, spheres, etc. The need to accurately locate small flaws (1/8" x 1") introduced during fabrication below the surface of the elastomer part is critical to the safety, operational performance, proof testing, and quality assurance of such parts. This effort would use the innovative implementation of existing and new technology to design and fabricate a suitable sensor system for the above application.

Existing methods used for NDT include low frequency ultrasonics, xerography, tomography, and fluoroscopy. Ultrasonic methods are well suited for measuring the thickness of a rubber part, but have difficulty in conveying the orientation, overall size, and type of the flaw. X-Ray methods such as xerography and fluoroscopy have been used to locate flaws, but their accuracy is susceptible to the orientation of the flaw with respect to the X-Ray beam.

PHASE I: Develop innovative concept design(s) and a breadboard demonstration in sufficient detail to assess performance and cost of a manufactured device.

PHASE II: Fabricate prototype device and conduct in-situ evaluations with actual or elastomer components. Optimize performance and accuracy while maximizing repeatability.

PHASE III: Manufacture production device packages including operating instructions and specifications. Sell devises to Navy and/or manufacturer of Elastomeric Ejection System components, or other highly strained elastomeric components, for production quality control, product acceptance tests, and in-service quality inspection.

COMMERCIAL POTENTIAL: The use of elastomers and rubber materials in industry and consumer products is ubiquitous. Flaw locating and plotting capabilities will not be limited to highly strained disks and spheres. This technique will enable manufactures to routinely inspect prototypes during product development as well as production and in service hardware.

REFERENCES:
1. Halsey, G.H., Nondestructive Testing, Rubber Age, February, 1968.
2. Dodge, D.D., Principles and Applications of Non-destructive Testing, American Society of Mechanical Engineers, Paper No. 61-WA-323, 1961.

KEY WORDS: Non Destructive Testing; NDT; sensor; elastomer; transducer; rubber

N99-092 TITLE: Prediction of Prototype Hydrodynamic Performance

SCIENCE/TECHNOLOGY AREA: Software & Hydrodynamics

OBJECTIVE: To accurately predict full scale vessel hydrodynamic performance from small scale model data.

DESCRIPTION: Develop a software-based process that accurately predicts the propulsion performance (forward speed, shaft speed, power required, vibration forcing function, appendage wakes, boundary layer turbulence, cavitation inception), and hull and appendage forces of a prototype marine vehicle system given small-scale experimental measurements. The task to meet the stated objective is configured into three phases:

PHASE I: The first phase will be to develop: (1) the physical phenomena that affects the prediction of prototype performance from small-scale data, (2) a review of the state-of-the-art for the prediction of these phenomena, (3) a prototype process that uses these prediction methods to address the task objective, and (4) an assessment of the feasibility in achieving the task objective. The range of applicability will be from length Reynolds numbers of 0.5x106 to 2.0x109. The envisaged system will meet the requirements of a designated NAVSEA Program Manager, possibly SEA 92R. NAVSEA will select the participating PM in order to bound the problem.

PHASE II: If the results of PHASE I recommend a viable process, PHASE II will focus on demonstrating that the controlling phenomena can be predicted with sufficient accuracy. This will be done using small-scale data and available prototype data. If additional code must be integrated to address system prediction requirements, it will be developed in this phase. The validity of the process will be demonstrated using available intermediate scale (1/4) data.

PHASE III: The successful completion of PHASE II will require the application of the process to a prototype system for final verification. This will include the definition of the experiment to be conducted, conducting the experiment, interpretation of the data, and comparison with predictions.

COMMERCIAL POTENTIAL: There is the potential for application of this process to a number of vehicle applications in the marine, aerospace, commercial aircraft and energy transfer industries. These industries all use some form of model testing in prototype design to open or close the design space. Fast accurate reduction of small scale data to full scale performance will save time and money while allowing consideration of more variants and better solutions.

REFERENCES:
1. AGARD, On Reynolds Number Effects and Simulation, Aerodynamic Data Accuracy and Quality: Requirements and Capabilities in Wind Tunnel Testing, July 1, 1988.
2. Reynolds Number Influences in Aeronautics, NASA TM-107730, May 1, 1993.
3. AGARD, Scale Effects on Aircraft and Weapon Aerodynamics, AGARD-AG-323, July 1994.
4. Halstead, D. E., Wisler, D. C., Okiishi, T. H., Walker, G. J., Hodson, H. P. and Shin, H. W., Boundary Layer Development in Axial Compressors and Turbines; Part 1 - Composite Picture, Part 4 - Computations and Analysis, Trans. ASME, vol. 119, January 1997.
5. Halstead, D. E., Wisler, D. C., Okiishi, T. H., Walker, G. J., Hodson, H. P. and Shin, H. W., Boundary Layer Development in Axial Compressors and Turbines; Part 2 - Compressors, Part 3 - Turbines, Trans. ASME , vol. 120, April 1997.
6. ONR Workshop Summary Report, Needs for High Reynolds Number Facilities to Design the Next Generation of Sea and Air Vehicles, June 18-19, 1997.

KEY WORDS: Scaling; boundary layer; computational; fluid mechanics; Reynolds number; water tunnel.

N99-093 TITLE: Electroconducting Non-Toxic Alternative Fouling Control Coatings/Systems

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: The objective of this work is to produce an effective, long life (5-7 years or more) antifouling system which is completely non-toxic to the environment. The US Navy currently takes advantage of ablative antifouling coatings based on cuprous oxide. Copper input into the environment from these coatings is coming under increased regulatory pressure. The need to develop non-toxic alternatives is greater than ever. Technologies under development to address these issues include low surface energy materials, co-polymer technology, and "booster" agents. However, silicone easy release (ER) coatings are not being implemented fleet wide, and the other technologies have not been proven and/or they rely on some level of toxicity in order to be effective. Recently several technologies based on alternating current conducting systems or pulsed DC power across a conducting coating have been developed which disrupt the settlement process of marine fouling animals. These technologies will be investigated for potential application to fouling accumulation on ship hulls, in tanks, and in cooling water systems.

DESCRIPTION: Several approaches have been considered in the past including some work with a material/coating, based on zinc chemistry, at Marine Environmental Research of North Carolina. These materials form a capacitively charged surface which releases zinc ions as an effective antifoulant.

In addition, it has been reported that Mitsubishi Heavy Industries of Japan has worked with electrically conductive coatings (trade name MAGPET) which deter biological fouling of submerged surfaces by releasing hypochlorite ions. The hypochlorite ions are released from the electroconductive coating when a small electrical current is passed through it. Hypochlorite ions are formed from the seawater and they degrade relatively rapidly in sunlight. (NOTE: this form of fouling control is related to chlorination procedures, and the EPA has placed restrictions on these practices.)

A third technology involves alternating current technology and has been designed to prevent the larvae of barnacles and other marine animals from settling by deploying a high frequency electrical field on a submerged surface. This system is based upon capacitance power transfer. An insulating coating is first applied directly to the submerged surface, followed by a conductive coating and then a second insulating coating that serves as a dielectric. Finally, electrodes are introduced to the seawater which from the other side of the capacitor. The conductive coatings and the electrodes are each then connected to an

AC power source. The system induces a current within the conductive bodies of larvae to disrupt the settlement process. The system can be switched on or off, depending on the operator's needs.

Another application of the alternating current technology involves the protection of the heat exchangers and cooling water intakes by ensuring larvae entering these systems are unfit for settlement. This technology involves a combination of insulated and uncoated metal plates hung vertically in a water intake or pipe between which passes a pulsed high frequency alternating current. Any larvae present in the water will be influenced by the electric field and will be rendered unfit for settlement. Inducing the current in the larvae makes it possible to utilize pulsed alternating current with a very low duty cycle thus resulting in relatively low power consumption.

The Old Dominion University has been working in the area of pulsed DC power to affect biological cells and therefore prevent settlement. The application of electric field pulses can stun aquatic species, and at increased fields induce mortality. The system is designed to provide microsecond pulses of up to 40 kV into a low impedance (<10 1/2) load. The system consists of an 8 KJ/s power supply which charges a pulse- forming network (PFN) with an impedance between 6 and 7 1/2 depending on the inductance of the PFN. The system is discharged through a circuit to provide a pulse to match a resistive load which is connected to the PFN via a stripline.

These emerging technology areas have been known for several years, but only recently have undergone development into potentially viable systems. They offer the potential to eliminate the need for heavy metal biocides and achieve long life performance.

PHASE I: Emphasis should be on development of materials/coatings that take advantage of the emerging technology area of electroconducting materials for marine/estuarine fouling control. Focus should be on development of materials/coatings/films for use on underwater ship hulls to prevent the accumulation of marine fouling. Proposals utilizing pulsed power or electric fields to control fouling in flows will not be considered. Phase 1 focus should be on material properties and evaluation of electrical inputs including voltages, frequencies, and duty cycles. Development of a pulse generator and/or switching device should also be addressed. The components and basic design of the system shall be defined.

PHASE II: Develop a prototype of the selected design and perform small-scale field tests.

PHASE III: Optimize system. Scale-up. Seek to transition technology to fleet.

COMMERICAL POTENTIAL: These coating systems have widespread application potential. The technology has potential for use in hull coatings, protection of power plants, steelworks, water treatment facilities, desalination plants, and a range of other industrial facilities using water for cooling or process purposes. There are significant offshore applications for prevention of fouling of ballast water tanks (and preventing introduction of non-indigenous species) and water systems on ships and platforms. This technology also represents a practical approach to a long-standing problem. It appears to be environmentally compatible while also offering the opportunity to be used on-demand (ie. Unused while ship is underway), thus extending the system life.

REFERENCES:

1. Proceedings of the Fourth International Zebra Mussel and Aquatic Nuisance Species Conference, "The Efficacy of Pulsed Electric Fields in Preventing Settlement of Zebra Mussel Veligers", 1994.

2. US Patent #5,653,052 dated August 5, 1997, "Method for Immobilizing or Killing Swimming Larvae in a Mass of Fresh Water and an Electric Trap for Practicing Such a Method".

3. Ocean Environmental Technologies, Inc. web site http://www.oet.net

4. Mitsubishi Heavy Industries web site at - http://www/mhi.co.jp/index.html

5. Schoenbach, K.H., F.E. Peterkin, R.W. Alden, III, and S.J. Beebe, "The effect of pulsed electric fields on biological cells: experiments and applications", IEE Transactions on Plasma Science, VOL 25, No. 2, April 1997.

N99-094 TITLE: Development of Total Ownership Cost Parametric Assessment Software Baseline Models for Ship R&D Concepts

SCIENCE/TECHNOLOY AREA: Software

OBJECTIVE: Provide Computer Simulation based assessment of future ship R&D needs through computer aided review of threats, mission requirements, existing research and development programs and promising technologies. Perform Total Ownership Cost (TOC) Analysis of technologies which have the potential to address these Navy needs. Conduct Total Ship System TOC assessments of key technology requirements and potential technological solutions outlined by the NAVSEA

Technology Assessment, Resources & Transition (TART) team. These feasibility studies will be of sufficient detail to determine the relevance and priorities of each technology with respect to Corporate NAVSEA product lines needs.

DESCRIPTION: Develop Object Oriented Modular Structures in C++ within the Parametric Analysis of Ships Simulation Model (PASS-ASSET) simulation environment. This environment will concist of PASS coupled with ASSET in accordance with the SEA 03 PASS-ASSET developed Specification for GUI and Object socket plug-ins.

PHASE I: Develop a set of three continuing base-line PASS-ASSET generated models (Destroyers, Carriers, Auxils.) with individual sets of technology needs within the existing PASS-ASSET environment. Address a sampling of critical TART team technology needs via PASS-ASSET Total Ownership Cost analysis. Deliver in concert with the NAVSEA TART team a Phase II plan outlining the near, mid and far term technology needs still remaining to be analyzed for the three continuing Baselines and the computer technology object models still required to be developed and or modified to permit systematic total ownership cost analysis of all these technologies.

PHASE II: Develop the computer object modules from the Phase I plans:
Add specified Ship Models to Databases General Benefit to Provide Common, Integrated AModel for Development; ! Build-Up Object Models Based on Physical and/or Functional Relationships Correlated With/Or Adjusted by Empirical Data Where Necessary. Perform and report to the TART team the expanded PASS-ASSET TOC technology assessments on the three continuing baselines of all the needs developed by the TART team. Prepare two annual NAVSEA Technology Needs Quantifications with their TOC Return on Investments reports for the NAVSEA TART team to assist in phase III transition planning.

PHASE III: Transition the fully developed PASS_ASSET R&D Total Ownership Cost Simulation model to SEA 03 and industry for continuing support of pre - milestone 1 ship design activities.

COMMERCIAL POTENTIAL: All Navy and commercial ships and boat design agents. The petroleum industry, Inland Barge Companies, Ferry boat operators, Towboats, Yachts companies etc. could utilize this computer based modeling capability to financially evaluate technologies impact on their products.
KEY WORDS: strainers; filters; self-cleaning; 5 microns

N99-095 TITLE: An Augmented-Gas-Turbine Propulsion Engine

SCIENCE/TECHNOLOGY AREA: Power and Propulsion

OBJECTIVE: To develop an advanced generation of propulsion engines.

DESCRIPTION: This SBIR addresses the problem of improving the performance of current surface-fleet propulsion plants. This will be achieved through the development of a hybrid gas-turbine engine incorporating combustor steam injection (CSI) and/or compressor-inlet, water-fog injection (WFI). The solution to this problem requires (1) analytical simulation of the off-design performance of these engine variants, (2) hardware tests to confirm the performance predictions, and (3) ship-impact studies to quantify the operational payoffs under a generic ship-powering profile. Specifically, the studies are to provide the overall spatial requirements, weight, and annual fuel consumption of the propulsion plant. They will also assess the plant's impact on other ship systems, such as water-management. All of the above factors will then be used in determining the ship's operational endurance and the total cost of ownership. The overall program has been subdivided as follows.

PHASE I: Develop concepts to establish the basic feasibility of proposed performance Gas Turbine, including methods for optimizing the turbine -inlet temperature (TIT) and steam-injection rate, while preventing overspeed or over-pressurization of the gas generator.

PHASE II: Develop analytical simulations of the off-design thermodynamic performance of the engine-cycle variants, which will include both WFI and WFI in combination with CSI. At discrete power levels, the fuel and water consumption rates will be computed and used to establish the annual consumption. The above analyses will be performed under second-law constraints, including thermodynamic integration of the heat-recovery steam-generator (HRSG) performance. Hardware tests of the engine variants will provide confirmation of the predicted power output, thermal efficiency, and water consumption. They will also yield the maximum WFI rate satisfying the surge and pressurization limits of the engine. These test data will then be used to produce preliminary designs and cost estimates for the reverse-osmosis desalination plant, the HRSG, and other major components. At this point, a determination will be made on which plant variants, if any, are worthy of a final ship-impact assessment, which will include Level-1 drawings and refined data on overall plant weight, size, and cost.

PHASE III: Design and fabricate all components of a shipboard prototype of the chosen plant, which will subsequently be installed and tested at a land-based site.

COMMERICAL POTENTIAL: Since all of the plant variants enhance both power density and thermal efficiency, they would have broad application to the power utilities.

REFERENCES on CSI:

1. Burnham J.B., Giulani, M.H., and Moeller, D.J., 1987, ADevelopment, Installation, and Operating Results of a Steam Injection System in a General Electric LM5000 Gas Generator, Journal of Engineering for Gas Turbines and Power, Vol. 109, 257-262.

2. Urbach, H.B., Knauss, D.T., et al., June 1997, AA Steam-Augmented Gas Turbine with Reheat Combustor for Surface Ships, ASME Paper 97-GT-254, presented at the International Gas Turbine and Aeroengine Congress, Orlando, FL.

REFERENCES on WPI:

1. Stambler, I., May-June 1997, A Spray Cooling Inlet and Compressor Flow Increases Hot Day Plant Performance, Gas Turbine World.

2. Wilcox, E.C., and Trout, A.M., 1950, AAnalysis of Thrust Augmentation of Turbojet Engines by Water Injection at Compressor Inlet, Including Charts for Calculating Compression Processes with Water Injection, National Advisory Committee for Aeronautics Technical Report 1006.

N99-096 TITLE: Low Cost Pultruded Polyurethane Composite Deck Stanchions

SCIENCE AND TECHNOLOGY AREA: Manufacturing Sciences and Technology

OBJECTIVE: To design and develop an improved, low cost composite deck
Stanchion for shipboard railing systems

DESCRIPTION: The Navy currently uses steel stanchions on board ships as part of the topside deck railing system. The stanchions are made of steel and require usual maintenance procedures to prevent corrosion. These steel poles have been shown to interfere with radar systems and are therefore not kept in place on radar platforms. In addition, they add to the ship signature if left in place. There have been efforts to replace the steel stanchions with composite materials, but with limited success. The prime problem has been damage tolerance of the composite part. Large impacts from cranes and heavy machinery tend to cause catastrophic failure of the composite, whereas metal parts are merely bent and can be straightened. An alternative material system such as fiber reinforced polyurethane, which is both structural and compliant, could solve the problem. A ship set of fiber reinforced polyurethane stanchions have been manufactured and outfitted for shipboard evaluation. These stanchions were filaments wound. To make these parts attractive to the fleet, a more cost-effective procedure needs to be established. Pultrusion of fiber reinforced urethane parts could potentially provide significant cost reduction which would make acquisition costs comparable to metals. The continuous pultrusion manufacturing technique is the lowest cost process in the composites industry. The purpose of this program is to develop a pultrusion technique, which uses a high strain to failure matrix material such as polyurethane (strain to failure of 300-400%) to manufacture composite parts with uniform cross section such as stanchions. This part would provide reduced life cycle costs, more damage tolerant structures which would reduce the ship signature. A Pultruded polyurethane composite deck stanchion holds the promise of enhanced performance at an affordable acquisition cost.

PHASE I: Design the composite structure including fiber format selection and orientation. Choose appropriate urethane material, which can be used in a pultrusion process. Demonstrate fabrication and structural performance of a pultruded stanchion like structure. Provide joining concepts between the stanchion and deck.

PHASE II: Develop, fabricate and test a full-scale deck railing system based in the stanchion design from PHASE I. This shall include the chain (or other) rail and stanchion end caps. The system should be tested for radar signature and damage tolerance/load carrying capability.

PHASE III: Transition to installation of the composite deck stanchion system to radar platforms and other critical locations. Transition to other naval ships such as the retractable stanchions at the elevator hangers on carriers.

COMMERCIAL POTENTIAL: Corrosion resistant systems are required in many commercial applications including marine and off shore oil applications. The use of pultruded polyurethane composite tubing, in general, has applications well beyond stanchions including low vibration piping systems and flexible torsion shafts.

REFERENCES:
1. Crane, Roger M. and Ratcliffe, Colin P., A Graphite/polyurethane Flexible Composites: Mechanical and Vibration Damping Properties, Survivability, Structures and Materials Directorate Research and Development Report, CARDIVNSWC-TR-601-93/02 August 1993, 57p.
2. Ratcliffe, Colin P. and Crane, Roger M., and Santiago, Armando L., AFiber Reinforced Polyurethane Composites: Shock Tolerant Components with particular emphasis on Armor Plating, 1995 ASME Winter Annual Meeting, Nov. 12-17, San Francisco, CA.

KEY WORDS: pultrusion, composite materials, polyurethane, stanchion, impact resistant

N99-097 TITLE: Affordable NDM (Non-Distribution Media) Vacuum Assisted Resin Transfer Molding (VARTM) Processing for Large Naval Structures

SCIENCE/TECHNOLOGY AREA: Manufacturing Technology

OBJECTIVE: To develop a manufacturing process that utilizes the low cost vacuum assisted resin transfer molding process without the need for a distribution medium.

DESCRIPTION: New acquisition strategy for high technology Navy platforms is encouraging the use of composite materials, as is evident in the DD-21 Integrated Topside Design Program and as demonstrated in the AEM/S. Composite materials are an enabling technology which will provided improved stealth performance and therefore increased survivability. Acquisition costs remain a detriment to the implementation of composites into general fleet usage. The Vacuum Assisted Resin Transfer Molding (VATRM) fabrication technique has demonstrated the ability to easily incorporate internal features for improved stealth and has shown the potential for affordable composite acquisition costs as was demonstrated in the AEM/S. The VARTM process, however, is both labor and material (consumable) intensive. Touch labor is required to place infusion media which is later discarded, and should the media be built into tools, structural foam, or vacuum bags, large capital asset outlays and touch labor are again required. To streamline manufacturing and reduce costs, a process is required that eliminates these consumable wastes and touch labor associated with VARTM. The accomplishment of cost-effectiveness will require the integration of a distribution media into the actual structural materials. This would allow the elimination of consumables, large percentages of touch labor, and an overall simplified VARTM tool and bagging techniques. In addition, cores placement, which also constitutes a large percentage of touch labor, could also be streamlined as foams could be cast in place since resin grooves would no longer be required.

PHASE I: Develop and demonstrate a VARTM like manufacturing process which could be utilized to manufacture large scale (up to hundreds of square feet) cored structures using resin systems such as vinyl ester (e.g. Dow 510-A, 8084) which does not utilize a distribution medium. The potential range of skin thickness envisioned are up to 1 in. In addition, the technique should be capable of manufacturing structures with nonuniform cross section.

PHASE II: Demonstrate the low cost aspects of the manufacturing technique through detailed cost modeling/verification of the process which will be demonstrated on a structural component of the size and complexity of the AEM/S. The specific structure will be identified prior to the start of PHASE II.

PHASE III: Utilize the low cost manufacturing technique for the manufacturing of Topside structural components required for DD-21 Integrated Topside Design. This technology could be utilized for the manufacturing of structural components for numerous other platforms including decks, stacks, foundations, and small craft hulls.

COMMERCIAL POTENTIAL: Development of this process could make composite materials affordable in other technology sectors. For example, this process could be used in the manufacturing of large civil structures such as bridge decks, railroad boxcars, barges and pleasure craft.

REFERENCES:
1. Bernetich, K. R., R. M. Crane, B. K. Fink, and J. W. Gillespie Jr., Co-injection Resin Transfer Molding of Vinyl Ester and Phenolic Composites, to be published in the Proceedings of the 43rd International SAMPE Symposium/Exhibition, Materials and Process Affordability, Keys to the Future, Anaheim, CA, May 3-7, 1998.
2. Lazarus, Paul, "Competing Composites" Professional Boat Builder , Aug/Sept. 1997

KEY WORDS: VARTM, composite materials, vinyl ester, low cost

N99-098 TITLE: Mechanical Holders for Advanced Sliding Electric Contacts

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: Develop mechanical holders compatible with present state of the art metal foil and metal fiber brushes.

DESCRIPTION: Recent developments have demonstrated that metal foil and metal fiber brushes can be fabricated which have higher contact current densities than conventional graphite or silver-graphite brushes with a lower rate of wear. Metal foil or fiber brushes may have application in both commutating and non-commutating electrical machines, including advanced direct current machines such as a superconducting homopolar motor.

Metal fiber and foil brushes require lower contact pressure. Existing mechanical holders in conventional machinery are not compatible with these brushes. Current brush loading pressures are between 2.4 and 4.0 psi. Metal fiber and foil brush performance is maximized when they are subjected to a brush loading pressure of 1.0-2.0 psi. This reduction in brush loading will increase wear resistance, increase efficiency, and will in turn greatly reduce the labor and cost associated with current fleet brush maintenance difficulties.

PHASE I: Develop innovative mechanical holders compatible with metal foil and/or metal fiber brushes for use in existing and proposed electrical machines. A report will describe the basic design including the applied mechanical load, required design space, and brush replacement. However, in general, a brush loading pressure of 1.0-2.0 psi is desirable for metal fiber and foil brushes. Brush in service life for naval application motors varies greatly. Brush replacements are required as frequently as 744 hours for some DC commutating motors, while others require replacement as infrequently as 4650 hours. Because of the light loading conditions associated with the metal fiber and foil brushes, the occurrence for electrical arcing is minimized and conversely, brush life maximized. The metal fiber and foil brush provides a potential increase of in service life of 5 times that of existing brushes. Existing brush holders are manufactured from cast brass. The brush holders should accommodate movement of up to 50% of brush initial length to accommodate wear. The brush holders should be designed and manufactured to withstand orthogonal(i.e. perpendicular) forces of magnitudes on the order of 5 times as those seen by normal forces exerted on the brush at the running surface. The brushes and brush holders should be manufactured to operate in environments of 55-100 degrees centigrade during motor full load applications. Current naval application brushes are carrying current densities that range from 18 Amps/in2 to 71 Amps/in2. In the near term, the brush holders will need to be compatible with these levels of current density. However, to meet far term goals, the brushes would need to accommodate current densities exceeding 2000 Amps/in2 as demonstrated in recent studies of both commutating and slip ring brushes. Additionally, because of imposed space constraints, the brush holder thickness should be minimized to not exceed 10%-20% of the thickness of the brush running surface. The brush holder must transfer the current from the fixed armature to the sliding brush (e.g., standard pigtail) without affecting the low (1-2 psi) normal load at the running surface. Furthermore, this flexible shunt should minimize electrical loss of the brush while retaining the aforementioned travel flexibility.

Note: The parameters suggested on the previous page serve as desirable guidelines for the performance of the brush holder and not as Ahard and fast specifications. It is fully understood that the final brush holder configuration will be an optimized solution using the given performance guidelines.

PHASE II: Select the designs best suited for naval applications. Demonstrate the mechanical holders developed in PHASE I. Complete detailed design, document the required fabrication process, and fabricate a minimum eight brush holders which can be tested with either advanced fiber and/or foil brushes on an appropriate test fixture.

PHASE III: Based on the final selection of the optimum brush technology by the Navy, integrate the brushes in a fully populated mechanical holder in an operational system and verify the performance.

COMMERCIAL POTENTIAL: High performance brushes are an enabling technology for any advanced direct current electric machine. Principle applications include machinery which require high torque and loads which require high currents. High torque electric motors are used in shredding machines, paper mills and punch press drive systems. Potential transportation systems include conventional electric trains, electric cars, and magnetically levitated trains. Compact, high performance DC generators will have applications in the electroplating industry and pulsed electric welding sources such as used in the offshore drilling industry. High current, low voltage DC electric machines will provide the most efficient, reliable method of using environmentally attractive alternate low voltage energy sources such as solar, thermoelectric, and fuel cell technology.

REFERENCES:
Walters, J.D., et.al., Reexamination of Superconductive Homopolar Motors for Propulsion, Naval Engineers Journal, January 1998, pp. 107-116.
D. Kuhlmann-Wilsdorf and D. Alley, Commutation with Metal Fiber BrushesÓ, in Electrical Contacts 1988, see also IEEE Trans. CHMT Vol. 12, pp. 246-253, 1989.

KEY WORDS: Brushes; Direct Current; Slip Rings; Mechanical Holders

N99-099 TITLE: High-Speed `Hot Chip' Motherboard

OBJECTIVE: To develop a standard affordable convection cooled motherboard for very high speed commercial processors or "hot chips".

DESCRIPTION: The heat dissipation of very high speed commercial processors or "hot chips" requires forced air cooling or conduction cooling with large heat sinks. Both fans and heat sinks occupy a significant amount of space and often limit the application of the "hot chip" processors. The commercial industry (i.e. Force, Motorola) have always desired, but have not obtained, a cost-effective convection cooled motherboard. The Navy has faced similar problems in the past and addressed the issue by using unique ceramic boards in custom enclosures. However, the high cost and limited success of this approach always restricted the use to expensive, mission critical applications.

The following paragraph appears on the Intel web page: "Two big reasons why a desktop processor must be adapted for a mobile PC are heat generation and heat dissipation. If left unchecked, high temperatures can compromise the processor's and the computer's performance and reliability. The more power a chip uses, the more heat it generates. Intel develops mobile processors that use much less power than desktop processors. For example, the latest desktop 333Mhz Pentium II processor consumes almost twice the power of the 266MHz mobile Pentium II processor. Quickly removing the heat that a computer inevitably generates is difficult within the confines of a compact mobile PC. Intel has adapted desktop cooling solutions to the mobile environment by using miniature fans and heat sinks, devices similar to your car's radiator, to quickly draw heat away from sensitive components and dissipate it to the outside air."

Intel's latest family of processors requires that the devices will operate at a case temperature range of 0 degrees Celsius to 85 degrees Celsius. At 85 degrees, the necessary airflow over a processor with a unidirectional heatsink is 600 feet/minute. This is obtainable by the cooling fans used today. However the power dissipation of todays processors is half the heat dissipation of the processors that we shall see two years from now. The heat dissipation requirements of new processors shall quickly overtake the heat dissipation capabilities of mobile processor environments.

New and innovative ceramic materials and bonding agents have demonstrated improved thermal dissipation properties over the previous generation of ceramics. These technology improvements are becoming available and need to be adapted and implemented. New designs for integrated circuit carriers shall be explored with the various manufacturers. Design of the actual convection cooled motherboard shall be done with input from the major processor manufacturers. The combination of improved ceramics, bonding agents, carrier designs and the new convection cooled motherboard will support the heat
dissipation requirements for "hot chip" processors. These combined technologies would provide convection cooling of these "hot chips" without utilizing large heat sinks or cooling fans. Typical space savings from the removal of fans could consist of 16 cubic inches. Ventilation requirements could drastically be reduced by two thirds. This approach would support enhanced system performance and would reduce the system cost associated with cooling the processors.

PHASE I: Develop a detailed design for a standard convection cooled motherboard for "hot chip" processors.

PHASE II: Fabricate, test, demonstrate and deliver to the Navy a prototype of the convection-cooled motherboard with two or more of the commercially available "hot chips."

PHASE III: Fabricate and test production configurations of the standard convection cooled motherboard for "hot chip" processor applications.

COMMERCIAL POTENTIAL: The commercial applications of a standard convection cooled motherboard would include those requirements where increased processing performance is desired in a limited amount of space. Examples of these applications might include wearable computers, automotive electronics and commercial satellites.

REFERENCES:
1) Feinstein, Leo G. "Die Attachment Methods in Packaging", Vol 1 of ASM Electronics Materials Handbook. Materials Park, OH: ASM International, 1989.

KEY WORDS: Integrated; Circuit; Bonding; Cooling; Convection; Processors

N99-100 TITLE: Cost Effective Integration Methods for Large Complex Systems

SCIENCE/TECHNOLOGY AREA: Manufacturing Sciences and Technology

OBJECTIVE: Develop techniques, tools, and approaches to accomplish timely integration of complex interface intensive systems. This should include ideas for remote software and hardware debugging and problem resolution to reduce the on-site support costs, COTS Vendor interaction, improvements in data correlation methods to manage resources and schedules.

DESCRIPTION: While the use of NDI/COTS products is not a new concept to the Navy, its application to highly elaborate weapon system developments such as the NSSN C3I System surpasses earlier complexity. The NSSN C3I System will be integrated at the COATS in the shipyard prior to shipboard installation. The ability to remotely debug and resolve problems encountered during this integration is highly desired since many subsystems/components are being developed at separate and remote contractor facilities. Debugging and resolving problems encountered during system integration will require the ability to correlate data assessed from the various contractor PTR databases as well as COTS OEM databases. Accurate scheduling and prioritization of resources is critical to ensuring that integration schedules are met.

PHASE I: Develop a methodology for remotely debugging and resolving problems encountered during integration of combat systems. Develop techniques or methods that could be used to assess the various contractor and OEM databases to support problem data correlation. Research and develop OEM test equipment/tools that could be utilized for integration efforts at the COATS.

PHASE II: Design and fabricate a proof of concept system/program based upon the PHASE I efforts that demonstrates the potential of a remote debugging capability utilized in concert with data correlation techniques and resource scheduling tools.

PHASE III: Based on a successful PHASE II effort, develop a series of remote debugging, data correlation, and resource scheduling systems/programs for use at the COATS in the shipyard and the various contractor facilities to support integration efforts.

COMMERCIAL POTENTIAL: This system could be applied in any environment where large scale COTS hardware and software systems are developed/integrated.

KEY WORDS: Integration, PTR, COATS, Debug, Resources, COTS Technology, Cost Reduction

N99-101 TITLE: Submersible Velocimeter (Acoustic, Pay-out and Others)

SCIENCE/TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a device to measure pressure, linear velocity, acceleration, position, of a projectile being launched from torpedo tubes. The device shall also be capable of measuring flow rate.

DESCRIPTION: At least two of many approaches should be considered for obtaining projectile dynamics. One (using an acoustic based method) which does not rely on line-of-sight and second using pay out of a thin Teflon type material. The acoustic method should incorporate a filtering algorithm imbedded within a programmable IC chip. The algorithm should be compatible with ALabView for Windows software and be optimized to filter ambient flow and launch related noise and determine projectile velocity, acceleration and displacement as a function of time. The second method shall incorporate two separate measurement devices for obtaining projectile dynamics, a tachometer with an optical encoder and a light emitting diode to generate displacement pulses. These and any other methods proposed should have: all data shall be passed in real-time via both analog (full bandwidth) and a serial port with an effective data rate of no less than 200 Hz; all sensors are to reside in a rugged compact waterproof housing to withstand submergence pressures up to 1000 psig. The housing will interface with either Mk 48 or Mk 42 breech door electrical penetrator inside the torpedo tube and pass data through select pins within the penetrator. The housing will enable easy access to sensors for maintenance, replacement, and repair. The payout material and spool should be readily accessible without involving disassembly.

PHASE I: Research and develop the use of off-the-shelf instrumentation and/or equipment that will enable the monitoring of torpedo displacement, acceleration, tube door pressure, and velocity during the launch process without breaking the Submarine Safety (SUBSAFE) boundary. Candidate pressure, flow, and accelerometer MicroElectroMechanical (MEMS) sensors that were evaluated by the ONR 6.2 Undersea Warheads and OSD CTIP programs will be considered. The acoustic velocimeter sensors should be remote (no contact with projectile being monitored) using acoustic-based technology and have the greatest potential for monitoring the projectile dynamics without line of sight. The pay-out velocimeter will be developed using a wire spool pay-out system which will reside inside the torpedo tube during launch. Develop preliminary drawings of a waterproof enclosure which will house the selected sensors and mate with either Mk 48 or Mk 42 breech door electrical penetrators inside the torpedo tube. Develop preliminary drawings of the cable/signal interface which will mate with the dry side Mk48 or Mk42 electrical penetrators. Any other methods proposed should use similar techniques for ship integration.

PHASE II: Finalize the design and build laboratory grade prototype using the most promising concepts identified in PHASE I. Conduct laboratory tests to include an initial proof-in period and fine-tuning series (to obtain the best signal quality and repeatability). Data will be collected in parallel with an existing Pressure Velocity Displacement (PVD) assembly to ensure displacement, velocity, and acceleration data are comparable. The units shall provide accurate, repeatable pressure, velocity, acceleration, and displacement verses time data via the tube door penetrator in real time (200Hz effective data rate).

PHASE III: Redesign prototype for compactness, ruggedness, and ease of maintenance and repair. The unit must withstand MIL-810E 516.4 Procedure IV Transit Drop Test and MIL-810E 514.4 I-3.4 20-1000 Hz 0.4G2/Hz, 1000-2000Hz -6dB/Oct at one hour per axis. The unit shall be compact (fit within the space between the breech door and the Torpedo Mounted Dispenser), designed to withstand launch pressure pulses at depth pressures up to 1000 psig. Conduct laboratory tests to proof the ruggedized prototype followed by final shipboard tests to include launching dummy torpedo shapes. Data is to be collected in parallel with an existing PVD system to ensure displacement, velocity, and acceleration data are comparable.

COMMERCIAL POTENTIAL: These units will be useful for military or commercial applications towards monitoring projectiles being launched under water without having line of sight on the projectile. The sport diving industry could utilize such a device towards determining the performance of various spear guns , snares, or retrieval mechanisms. Salvage equipment companies could use it to design industrial retrieval mechanisms or determine distance of various underwater targets.

KEY WORDS: Submersible acoustic velocimeter; non-contact velocimeter, velocimetry, projectile dynamics measurement, wire payout measurement systems

N99-102 TITLE: Automated Test & Integration Methods for COTS Hardware & Software Components

SCIENCE/TECHNOLOGY AREA: Manufacturing Sciences and Technology

OBJECTIVE: Develop an innovative approach to testing COTS and government unique components using a hot box concept for pre-integration automated testing. Other concepts may be pursued as well. Develop a prototype system that is uniquely capable of improving the logistic and testing process of individual components and/or system level components. Reductions in combat system testing and supportability will result in a significant cost and time savings to Navy developments.

DESCRIPTION: Current combat system developments are making extensive use of COTS technology that will require frequent technology updates/insertions. Present combat system supportability requires extensive logistics material and dedicated training for maintenance and testing of complex system components. Development of a commercial test system that is capable of testing individual components and/or system level components has the potential to greatly reduce the logistics serviceability time constraints imposed upon complex systems. The ability to rapidly reconfigure the test system to support new technologies would be required. A common test system that could be utilized at Contractor Facilities, Shipyards and Depots would result in reductions in the development of logistics material and dedicated testing associated with complex combat system supportability. This will ultimately result in a significant cost and time savings to the Navy logistics supportability system.

PHASE I: Develop a feasibility study evaluating the potential savings in test, integration, and supportability cost and schedule through the use of automated test fixtures. Establish a detailed framework for the approach, identifying leveraging opportunities and other benefits of the new approach over existing processes. Identify efforts associated with the use of COTS test fixtures to improve complex combat system logistics support activities.

PHASE II: Design and fabricate a proof of concept system based upon the PHASE I feasibility study that demonstrates the potential capabilities of a component level automated test and support system.

PHASE III: Based upon a successful PHASE II effort, develop a series of component test and support systems for use in the both the development and field support activities associated with qualification, test, and evaluation of existing combat system programs.

COMMERCIAL POTENTIAL: These approaches to automated and streamlined testing are applicable to any activity that is integrating COTS products from multiple vendors or need to assess end-of-life (EOL) replacement components. Applications include all aspects of the computer industry from the personal computer to mainframe systems.

KEY WORDS: Automated Testing; COTS Supportability; Hot Box Testing; Cost Reduction, Depot Management, Integration

N99-103 TITLE: Towed System Improved Robustness

SCIENCE/TECHNOLOGY AREA: Manufacturing Technology

OBJECTIVE: Implement Innovative Materials and Manufacturing Technology to Improve Towed Acoustic Array Reliability Without Degrading Operational Performance

DESCRIPTION: Navy Towed Acoustic Array Systems as well as Geophysical Streamers are currently fabricated with the sensors, electronics, and interconnecting wires/optical fibers housed in a liquid filled hose as a water barrier and to support the hydrostatic pressure These acoustic arrays can be thousands of feet long and are towed from surface ships and submarines. This construction technique provides adequate acoustic performance, but is subject to poor reliability (mission failure) under the stresses resulting from both towing and handling system deployment/retrieval evolutions. Research into innovative applications of state-of-the-art technology (sensors, wire assemblies including connectors, optical fibers, and construction technology including non-liquid fill) is needed to improve the reliability and mission success probability without compromising operational performance. Application of this technology also should not negatively affect production nor life cycle support costs.

PHASE I: Conduct research and analytical studies to develop innovative component and/or construction technology that will improve towed acoustic array robustness, reliability, and toughness relative to normal operational exposure including at-sea towing, handling system (traction device and winch) deployment and retrieval cycles, and handling during maintenance, transportation, and storage evolutions. Specific improvements are required in ultimate strength; hydrophone and telemetry signal path integrity under bending tension and compression cycles associated with handling; exposure to seawater, chemicals, and sunlight for extended periods; improved flexural and tensile strength/reliability at modular couplings, and more reliable electrical and optical conductors and connectors. Also to be addressed in the studies are preventive maintenance and repair maintenance associated with the new technologies and components as applied to the towed array systems.

PHASE II: Fabricate and test acoustic array sections or modules employing the new technologies for performance demonstration and evaluation. These tests will include both reliability and maintenance demonstrations as well as acoustic performance evaluations under actual towing operations at a certified Navy test facility. The test and evaluation array sections also must demonstrate the ability to achieve manufacturing and life cycle cost reductions while addressing state-of-the-art technology infusion (build-test-build).

PHASE III: The technology applications demonstrated in this SBIR Project will be implemented in Navy Towed Systems Programs (forward and/or back fit) for submarines, surface combatants, and surveillance missions by the SBIR contractor or transferred to Navy Prime Contractors as appropriate.

COMMERCIAL POTENTIAL: The technology is directly applicable in the geophysical and seismic exploration industry for the design, development, and operational use of single and multiple seismic streamers.

KEY WORDS: Acoustic Arrays; Robustness; Reliability; Performance; Innovative Technology; Innovative Materials

N99-104 TITLE: Towed System Marine Life Attack Reduction

SCIENCE/TECHNOLOGY AREA: Materials, Processes, Structures

OBJECTIVE: Identify Stimuli Causing Marine Life Attacks on Navy and Geophysical Towed Acoustic Arrays and Identify Practical Modifications or Countermeasures to Prevent the Attacks.

DESCRIPTION: Navy Towed Acoustic Array Systems operate in a harsh environment and are experiencing significant operational failures resulting from attacks by marine life, particularly shark and other fish bites. It has been hypothesized that the bites are a result of low frequency vibration associated with the tow platform and/or towcable strumming, visual attraction of the array's motion through the water, electric fields associated with the array internal power and telemetry components, and smell associated with array materials or ISOPAR fill fluid. Research into the specific causes of the marine life attacks, as well as identification of potential solutions and/or countermeasures that can be implemented without degrading operational performance, are required to improve system reliability and mission success rates.

PHASE I: Conduct research and analytical studies to evaluate current design and operational parameters, including geographical areas in which the most attacks have occurred. Research the most likely sources of attraction and bite response stimulation. Based on this research and analysis, develop practical recommendations for array design, construction, and operation modifications which will make the arrays less susceptible to marine life attack without degrading operational performance. This effort also should address the application of practical active or passive countermeasures to reduce attacks by marine life during operational use.

PHASE II: Design and fabricate appropriate test components simulating the operational parameters of actual towed acoustic array systems, and conduct testing to validate and verify the attraction and bite stimuli identified from the PHASE I research and analyses. The test program also should evaluate practical changes to the array operational parameters that reduce these stimuli, and evaluate the design and use of potential active and passive countermeasures that reduce marine life attack, as recommended from PHASE I.

PHASE III: The techniques for reducing marine life attraction and bite response stimuli identified in this SBIR Project will be applied to Navy Towed Systems Programs for submarines, surface combatants, and surveillance missions by the SBIR Contractor or Navy Prime Contractor as appropriate.

COMMERCIAL POTENTIAL: The technology is directly applicable in the geophysical and seismic exploration industry for the design, development, and operational use of single and multiple seismic streamer configurations.

KEY WORDS: Acoustic Arrays; Marine Attack/Bite; Attraction Stimuli; Bite Stimuli; Reduction; Countermeasures

N99-105 TITLE: Compact Terabyte RAID Disk Subsystem

SCIENCE/TECHNOLOGY AREA:Command, Control and Communications

OBJECTIVE: Develop a multi-terabyte COTS-based, high-reliability, high-bandwidth, high-availability data storage subsystem in a 10 U 19' rackmount box suitable for submarine use. The box shall be air-cooled, shock-resistant, and support a dual ported Fast and Wide SCSI interface. The target price of a one-half terabyte (TB) array is $50,000 in the year 2000 AD. The anticipated increase in storage at a constant cost as a function of time is linearly proportional to the industry-wide increase of disk capacity at a constant OEM cost.

DESCRIPTION: Due to the large volume of data involved, current submarine combat systems record data for mission reconstruction only to high-density removable media. This data is not accessible during normal operations, which limits the level of detail of on-board event reconstruction. This problem will become much worse with next-generation combat systems.

Space, power, and weight constraints prevent current generation RAID products from storing all of the mission data on-line. A multi-terabyte capacity, low-cost, low-weight, low-volume, low-power on-line data storage subsystem would allow ready access to that data which is currently unaccessible, and greatly facilitate on-board event reconstruction.

For ease of integration, the data storage sub-system shall appear as a standard Fast-Wide SCSI storage device to each of two host processors. The dual-porting shall be transparent to the host processors, which shall use standard SCSI driver software. The target host processors are HP VME-bus processor cards running HP-UX 10.20 or higher, and Pentium II processors running Windows NT 5.0 or higher equipped with a suitable SCSI host adapter.

PHASE 1: Research storage subsystem interface technologies such as "FireWire" and Ultra-SCSI, and storage technologies not limited to conventional hard disk drives. Develop a design plan for the construction of a dual channel data storage subsystem controller with a storage capacity of at least 500 gigabyte (GB) for mounting in a standard 19' equipment rack. The controller interface shall be Fast-Wide SCSI with no special drivers required on the host side. The goal is a self-contained array with on-line error correction, monitoring, and diagnostics in a 10 U package. The data storage subsystem should also be a modular as possible to facilitate on-line repair (hot-swapping of storage modules) and maintenance. If a storage module is replaced, the array shall automatically rebuild the data on the replaced module.

PHASE 2: Produce a prototype storage subsystem with on-line error correction, monitoring, and diagnostic functions. Write a test plan to demonstrate hot-swappable replacement of disks and autonomous recovery of data while the array continues to operate on-line. Testing shall be done with the both of the target host processors. The target host processors are HP VME-bus processor cards running HP-UX 10.20 or higher, and Pentium II processors running Windows NT 5.0 or higher equipped with a suitable SCSI host adapter.

PHASE 3: Production of selected solution. The production units shall comply with military environmental standards when properly mounted in an NSSN SEI or equivalent enclosure. The target price for a 0.5 TB array in the year 2000 AD is $50,000, with capacities at a constant cost increasing linearly with the industry-wide increase of disk capacity at a constant OEM cost.

COMMERCIAL POTENTIAL: This SBIR topic would have potential commercial application to systems requiring on-line storage requirement. (Libraries, WEB Servers)

KEY WORDS: Data Storage, RAID, Hard Disk, Information Systems

N99-106 TITLE: Apply State of the Art Technology to Submarine Systems Maintenance

SCIENCE/TECHNOLOGY AREA: Manpower and Personnel Systems

OBJECTIVE: Develop and apply technologies to automate the maintenance of submarine systems inclusive of telepresence/virtual reality. A portable watchstander digital assistant device should be considered as an element of the telepresence/virtual reality system. Application of telepresence and virtual reality technologies for supporting submarine systems maintenance by allowing supervisory personnel to remotely view maintenance activities, in a wide variety of maintenance procedures (virtual/synthetic environments). The portable, easy-to-use digital device, should enhance the situation awareness and thus effectiveness of submarine non-propulsion watchstanders/maintainers.

DESCRIPTION: Maintenance on submarine systems can often occur in limited access environments. In those situations, telepresence, would allow others to view the work area while maintenance/repair is being conducted. One application would have the digital/audio/video device be man-mounted. Another application could be in a non-man-mounted form, such as mechanical arm or robotic device. The telepresence data could be viewed conventionally, on a monitor, or less conventionally, using "virtual-reality" headsets. Virtual reality would allow for repairs or maintenance of equipment that must remain "on-line" or is in hazardous environments.

Recent advances in portable computing make clear the potential for hand-held devices, which can support tactical and non-propulsion engineering watchstanders aboard submarines. Currently, information for watchstanders not assigned to a specific console must be captured and managed through status boards, log sheets, and other non-electronic means. Such schemes typically make difficult such critical functions as trend analysis, "what if" exercises, and data fusion across multiple sources. A portable digital device used dually for watch standing data support and telepresence/virtual reality would provide a resource for Technical Assistance, watchstander training as well as enhanced data fusion. Use of this device and the information gathered could give a supervisor a virtual status of the entire ship.

PHASE I: Research and define requirements and execute preliminary design of one or more telepresence and/or virtual reality solutions which includes watchstander support. Include the necessary hardware and software elements.

PHASE II: Produce/Develop a prototype "unit". Demonstrate functionality in controlled lab conditions. Further demonstrate functionality onboard a vessel. Also plan for cost effective production of the unit.

PHASE III: It is expected that the contractor will undertake the production and commercial sale of the successful device.

COMMERCIAL POTENTIAL: The technologies developed in Phase II will have applications in the private sector for system maintenance. A portable device which allows operations personnel to become more attuned to their duties has benefits in any process-intensive industry. Examples include manufacturing, power plant operation, and telecommunications system operation.

KEY WORDS: virtual reality; telepresence; maintenance; situation awareness; watch station; tactical decision aid; submarine; watchstander; portable digital assistant

N99-107 TITLE: Environmentally Friendly Fill Fluid

SCIENCE/TECHNOLOGY AREA: Chemistry

OBJECTIVE: Develop or identify an environmentally friendly fill fluid to replace currently used hazardous fluids. It must be non-reactive with a variety of materials, electrically non-conductive, thermally conductive and less dense than seawater. It should also be non-toxic, and not have any special handling requirements.

DESCRIPTION: The Navy currently uses synthetic and petroleum based oils as fill fluids in various undersea applications. Most of these oils are hazardous to the environment and humans. Some of them are also extremely flammable if allowed to evaporate. The Navy would like to replace these fluids with more benign materials in future systems.

PHASE I: Develop or identify an environmentally friendly fill fluid. It must have similar density, viscosity, and other physical properties as currently used fluids. It must also be non-reactive with electronics, polyurethane, Kevlar, and other materials used in Navy systems.

PHASE II: Produce some sample fluids, and demonstrate that they meet the Navy’s needs. Perform material and acoustic compatibility studies.

PHASE III: The fluid developed in Phase II will be produced for use in future Navy towed array systems for submarines, surface combatants, and surveillance missions by the SBIR Contractor or Navy Prime Contractor as appropriate.

COMMERCIAL POTENTIAL: The commercial market always has use for new environmentally friendly products. The oil industry also has some similar systems to the Navy’s that use fill fluids of this type.

KEY WORDS: fill fluid; environmentally benign; non-flammable; oil; non-reactive

N99-108 TITLE: Network Based Training

SCIENCE/TECHNOLOGY AREA: Computer Science

OBJECTIVE: Develop an innovative network centric training device concept based on the latest Commercial off the shelf (COTS) which provides a common hardware environment and software to support existing display formats and Operator Machine Interface (OMI) for sonar sets, other sensors and Command and Control functions.

DESCRIPTION: Providing realistic sonar, command and control analysis’ has been a top Navy priority for more than 40 years. Many approaches to this training have evolved over the years ranging from simple single channel tape playback of the targets audio signals to sophisticated and expensive target simulation hardware and software. Operators are required to perform sonar, command and control and other sensor analysis in a diverse set of conditions against a large category of targets while operating a variety of systems. Naval training experience has shown that training the operator to perform analysis in a tactical system environment using real world data and target signals is the most effective. The simulation of this environment can be accomplished by taking advantage of the latest commercial Digital Signal Processing (DSP), PC workstation, high resolution display and data storage and replay technology. PC based systems can be programmed to provide the various displays, display formats and Graphical User Interfaces (GUI) associated with the tactical systems currently deployed in the Fleet. Networking student workstations and an instructor workstation with a common data source DSP will provide a low cost, very flexible and realistic training environment.

PHASE I: Develop an innovative network centric training device concept based on the latest Commercial off the shelf (COTS) PC and DSP technology. The training device should provide a common hardware environment and software to support existing display formats and Operator Machine Interface (OMI) for existing submarine, surface and airborne sonar, other sensors and command and control functions.

PHASE II: Design and fabricate a prototype training device developed under Phase I of this effort. The device should be able to support at least 10 student workstations and 1 instructor station connected to a common data source DSP server.

PHASE III: Based upon a successful Phase II effort, develop and produce these training devices for the various US Navy ASW Training Centers to support basic and master level analysis training as well as pre-deployment training.

COMMERCIAL POTENTIAL: This research and development effort can apply to any training application where multiple students can be trained using high resolution video data display workstations connected to a common training data source over a network.

KEY WORDS: command & control function, other sensors, sonar; acoustic analysis; network based training; display formats; and Operator Machine Interface (OMI); Digital Signal Processing (DSP)

N99-109 TITLE: Enhancement in the Probability Detection of the Electronic Warfare Support (Es) Systems Against Modern Radars That Use Pulse Compression Techniques for Improved S/n Ratio

SCIENCE/TECHNOLOGY AREA:Electronic Warfare

OBJECTIVE: The objective of this effort is to develop an inexpensive and compact ES receiver to detect radars that use pulse compression or matched filtering technique to avoid unwanted compromise between range and resolution typically necessary in a traditional radar design.

DESCRIPTION: Modern radar systems, generally classified as Low Probability of Intercept (LPI) radars, use pulse compression techniques. These radars can frequently transmit at very low peak power levels since the radar receiver is matched to the modulation pattern of the transmitted signal. Matched filters used in such radars depend on the type of modulation on the transmitted pulse. Traditional and most commonly used modulation is Linear Frequency Modulation (LFM), though Non-Linear Frequency Modulation and Pseudo-Noise Modulations are also used. High processing gain resulting from matched filtering provides detection range advantage for these radars over the intercept receivers. The fact that the signal may be spread over a broad segment of the frequency spectrum and transmitted at low power makes it difficult for an unmatched Electronic Warfare Support receiver to detect the signal at any significant range or at all. This means that, depending on the radar cross section of the target platform and the gain of the receiving antenna, the radar may be capable of detecting the receiving platform at ranges greater than the receiver can detect the radar (resulting in a negative ES range margin). Since the purpose of an ES receiver is to provide warning of the presence of a radiating platform at ranges greater than that at which the radar can detect intercept platform, it may be necessary to employ new ES receiver types to ensure positive ES Arange margin over these radar systems. One example of a radar that utilizes a FMCW modulation technique is the AScout radar that is advertised for use as an undetectable coastal surveillance and tracking system.

PHASE I: Develop an Electronic Warfare Support receiving system design concept that will provide detection of low power FMCW and pulse compression radars at ranges greater than the detection range of these radars against platforms that have moderate radar cross sections. The concept should develop approaches for countering the processing gain advantage of LPI systems over that traditionally provided by classical intercept receivers. Provide supporting analysis to demonstrate the detection range performance of the radar and the ES systems. The system concept must include the receiving antenna, internal system losses, receiver design and signal processing approach. Mechanically rotatable antennas may not be used and antenna dimensions must be limited to a cylindrical volume of five inches in diameter and five inches in height. Receiving and processing electronics must be mountable in Anineteen inch electronic cabinets and can not exceed a total volume of 2600 cubic inches. Detectability range margin analysis should consider radar cross sections of between 1 and 100 square meters and a range of radar effective radiated power levels.

PHASE II: Construct a laboratory prototype ES receiving system including an antenna and demonstrate key performance parameters in a laboratory test environment. Demonstrate how the equipment can be incorporated into a Naval ES system.

PHASE III: The successful system design will be integrated with existing naval ES Systems to provide enhanced LPI radar detection capability. Clearly identify and describe the expected transition of the product/process/service within the government as a result of the PHASE II in which the small business will participate under a PHASE III award.

COMMERCIAL POTENTIAL: The ES receiver has potential to be used on commercial ships to provide collision avoidance information.

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KEY WORDS: Electronic Warfare; Radar; Sensors; Modeling and Simulation; Electromagnetic; Antennas; Low Probability of Intercept.

N99-110 TITLE: <u>Investigation of Commercial Off-The-Shelf (COTS) Radio Products for Submarine Communications Support</u>

OBJECTIVE: Demonstration of the use of Commercial Off-The-Shelf (COTS) RF equipment for submarine applications

DESCRIPTION: New and enhanced Commercial Off-the-Shelf (COTS) RF and computer processing technologies have enabled the development of radio transceivers (one example is the Hughes AN/PSC-5 UHF SATCOM Terminal) that are compact, affordable, modular, and contain embedded Cryptographic (COMSEC), modems and Transmission Security (TRANSEC) capabilities. These products have been designed to be easy to operate and maintain, while providing total communications capability in one compact terminal. The objective of this Topic is to investigate the use of these new technologies to: a) replace existing legacy submarine communications equipment (such as the AN/WSC-3 UHF Transmitter/Receiver, the TD-1271 DAMA Unit and the external KG-84A COMSEC), which occupies considerable space and weight, requires considerable cabling, and is operator intensive equipment, and b) to introduce affordable new commercial telecommunications systems into the submarine using COTS transceiver products.

PHASE I: Develop a process to survey candidate technologies and products to satisfy the intent of the Topic for submarine communications systems, apply this process to a current submarine communications systems design, and develop a specific plan for a Phase 2 demonstration.

PHASE II: Design, develop and procure the necessary equipment and software to demonstrate the application of emerging COTS RF technology to reduce space, weight, power and to apply this technology to existing systems and to introduce new commercial telecommunications systems to submarines.

PHASE III: Integrate the results of the Phase 2 tasking into the NSSN Exterior Communications System and apply the processes and products towards the NSSN ECS Technology Assessment Process Plan.

COMMERCIAL POTENTIAL: The results of this effort are directly applicable to many facets of industry and Government. The smaller and inexpensive applications of the RF technology are obvious in every avenue of personal and industrial communications. The degree of difficulty and complexity increases as systems are developed that are a combination of military/military-like and pure commercial systems. The results of these efforts have direct application to airline communications systems, Federal Emergency Management Agency, Customs, Drug Interdiction efforts and other DoD service applications. Some of the technologies applied to DoD systems may have direct application to commercial applications in areas of communications security and mobility.

KEY WORDS: Communications, Radio, Telecommunications, submarine

N99-111 TITLE: Improved Sonar Detection Displays and Interfaces

OBJECTIVE: Develop improved methods for displaying the varied types of submarine sonar information to improve the operator's ability to detect and classify new contact information while taking advantage of flexible display interfaces.

DESCRIPTION: New submarine sonar systems currently in development are using increasingly sophisticated signal processing to detect modern submarines. These sonar systems are using UNIX X-Windows controls and displays for operator interaction with the signal processing software. Advances have now been made in capabilities of three-dimensional display options that should be incorporated into submarine sonar systems. Given these improvements, the number of processing options and displays in the current systems can overwhelm the operator. With only a limited number of sonar operators on board ship, there is a significant need to distill the amount of information available and display it in a manner that optimizes the operator's ability to recognize new contact information and classify the information as to its source. Improvements in operator performance can also be achieved by optimizing the signal processing and display interactions.

PHASE I: Research and analyze the type of information currently processed and displayed in the sonar system. Research the current controls and displays for the purpose of optimizing repetitive operator actions and usability. Develop a conceptual design for improved displays and operator interfaces that maximize the operator's ability to detect new contacts.

PHASE II: Complete the detailed design of the improved displays and prototype the displays for further evaluation.

PHASE III: The improved displays will be incorporated into the new submarine sonar systems currently under development. Detailed documentation and display software would be developed to allow the displays to be integrated into these sonar systems.

COMMERCIAL POTENTIAL: The capability to distill large amounts of information and present to the system operator in a user-friendly, simplified manner has applications to many industries. Examples include medical imaging, undersea exploration, and the monitoring of complex systems.

KEY WORDS: Sonar; display; processing; interface; detection; controls; operator

N99-112 TITLE: Optimization of Very Low Frequency (VLF) Headset Audio

SCIENCE/TECHNOLOGY AREA: Sensors, Sonar systems

OBJECTIVE: The objective is to develop technology to optimize acoustic frequencies to correspond to human hearing frequencies. This would allow sonar operators to better detect transients and other display characteristics that show up on Hull Array and Towed Array Broadband and Narrowband displays. Although this focus is on VLF, medium and low frequency would be a secondary option.

DESCRIPTION: Up to now towed array and low frequency bow mounted sonar's have never idealized the frequency coverage for human ears. Previous system improvements such as the AN/BQR-7 had lower frequency coverage which provided for detection and tracking of large volumes of contacts because of the longer range made possible with the lower frequencies. however, this improved system was not popular with sonar operators because of the audio. When sonar operators got off other systems that covered frequencies more ideal to the human ear and immediately sat at the AN/BQR-7; they couldn't hear as well because of the difference in frequency ranges. If the operators allowed their hearing to adjust to these lower frequency ranges, they were able to experience the detection improvements inherent in the AN/BQR-7. The basis of this research topic is to translate frequencies and, if necessary, perform frequency multiplication to increase the bandwidth and present the new idealized bandwidth to correspond to human hearing frequency ranges most suitable to the operators. All sonar technicians take hearing exams routinely which shows the variability of different persons hearing ranges. It would be optimal if the system could be calibrated to the individual since individuals hear differently and have hearing losses at different points on the spectrum. An innovative part of such a system would include a built- in hearing examination process which would calibrate the headset for each sonar operators specific needs. Subsequent re-calibrations could reoccur during the watch to help eliminate fatigue and strain associated with long periods of time on the sonar stack, especially during "battle stations" and "Fire Control Tracking Party" scenarios.

Training people to hear artificial frequency "aliases" would be the key to success of such a system. People would have to learn to think in terms of relative frequencies instead of discrete fixed frequencies. This topic would involve a sophisticated algorithm- driven higher frequency output that is tuned to each persons ear, at higher frequencies, most likely near 800 to 1000 hertz. Stereo and other advances in acoustics could also be used to enhance the oral detection process, which often enhances real time prosecution of lethal adversaries.

The initial concept would deal with experimenting with translating VLF signals of approximately 1 hertz to 150 hertz up to a frequency near 800 HZ and expanding the bandwidth to approximately 1000 Hz, thus providing frequency separation and better oral discrimination for the operators. Finite Infinite Response Filters (FIR) and Systolic Arrays would be implemented in the quest for self calibrating adaptive signal processing to re-map bandwidths for individuals.

PHASE I: Develop technology to optimize acoustic frequencies to correspond to human hearing frequencies. Although this focus is on VLF, medium and low frequency would be a secondary option. Perform simulations and experiments to demonstrate processes.

PHASE II: Develop a prototype to test dockside and at sea to prove suitability and applicability to acoustic oral detection capability and potential enhancements.

PHASE III: Turn over the technology to the private sector small businesses to manufacture and produce systems and hardware for the Navy.

COMMERCIAL POTENTIAL: Hearing aide companies and consumer electronics may benefit from this technology. Hearing impaired people may find new lease on life through frequency translation to bandwidths where they retain some element of hearing capability.

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KEY WORDS: FFT, FIR, Adaptive Signal Processing, Systolic Arrays, Frequency Translation, Frequency Multiplication

N99-113 TITLE: <u>JAVA Applications for Naval Combat Systems</u>

OBJECTIVE: Improving software code re-use and portability in Naval combat systems.

DESCRIPTION: The majority of software code in use today by Naval combat systems is custom written, and specific to a single hardware platform and operating system. However, the current trend is toward Commercial, Off-the-Shelf (COTS) hardware/software, with periodic technology updates over the ship’s life-cycle. This poses the possibility that substantial code re-writes may be required to be compatible with new hardware/software. This effort will assess and demonstrate the feasibility of using JAVA to improve software code re-use and portability in Naval combat systems. Significant life cycle cost savings can be realized through the elimination of non-recurring development costs by reusing previously developed software.

PHASE I: Identify candidate applications for using JAVA in an actual Naval combat system (e.g., New Attack Submarine). Develop a software specification to implement these candidate applications.

PHASE II: Develop the JAVA software applications and demonstrate their functionality and performance in a complex, laboratory test setting (e.g., the NSSN Wide-Area Integration Test Facility).

PHASE III: Deploy and extend the JAVA software applications in support of a broad variety of Naval combat system development programs, e.g., NSSN, DD-21, LPD-17 and/or CVX.

COMMERCIAL POTENTIAL: Software code re-use and portability is an issue for a wide variety of military and commercial computer systems.

KEY WORDS: JAVA; combat systems; re-use; portability

N99-114 TITLE: Ultra-Fast Portable Metallic/Concrete Plate Cutting

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: Develop man-portable technology and devices for ultra-fast cutting of metallic and concrete plates.

DESCRIPTION: Recent novel developments in cutting steel include combustion-synthesis-powered reactors that can project high thermal fluxes (ten megawatts per square centimeter). Concrete has been observed to melt and disintegrate when thermal lances burning at 4000#161#C are utilized. Both technologies have the disadvantages of being cumbersome and not man-portable because of heavy weight construction and umbilical-like fuel and oxidizer lines. Desired are devices that are small and lightweight enough to be used for salvage and rescue operations as well as underwater ship husbandry operations. Goals for salvage operations are a cutting rate of five feet per minute in a minimum of three-quarters inch plate and a maximum cutting depth of two inches.

PHASE I: Provide a feasibility study of the reactive breaching concept that includes novel cutting technologies and development of preliminary designs leading to ultra-fast cutting devices.

PHASE II: Develop these preliminary designs for lab-scale applied testing and evaluation useful for applications in the DoD and private sector. Deliver an experimental (bench-scale) working model to the Navy for evaluation as a cutting tool.

PHASE III: Develop a prototype of the selected cutting technology and device design. Fabricate and demonstrate the cutting device on concrete and steel that would have both military and private sector applications.

COMMERCIAL POTENTIAL: Salvage operations. Rescue operations in collapsed structures. Commercial and military demolition, breaching, and entry. Waterborne repair of ship's hulls and appendages.

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KEY WORDS: Reactive breaching; reactive materials; high-speed cutting.

N99-115 TITLE: Corrosion Preventative Storage Systems

SCIENCE/TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Storage systems to protect equipment against corrosion from long-term exposure during open area storage.

DESCRIPTION: Open area temporary land-based stowage systems have not been adequate in protecting against corrosion and other environmental effects. Many staging facilities and storage locations do not use effective means of protecting items like propellers or Harpoon missile launchers from the elements. This has induced increased maintenance, required larger inventory to compensate for degraded equipment, and demands excessive lead times for items to be declared ready-for-use. Furthermore, shipboard items including the anchor windlass, torpedo tubes, 50 caliber machine gun mounts, chaff decoy launchers, and saluting batteries are exposed to the marine environment continuously with little protection or radar absorbing stealth capabilities. Maintaining a high state of readiness for these items requires many man-hours of upkeep removing rust and corrosion. The Navy currently does not have an adequate temporary stowage system for topside shipboard equipment or propeller storage. Advances in synthetic fabrics and materials may provide new means for a temporary preservative storage capability that protects from the harsh marine environments and complement overall shipboard stealth technology.

PHASE I: Develop a storage system technology that completely protects shipboard torpedo tubes, 50 caliber machine gun mounts, chaff decoy launchers, saluting batteries, anchor windlass, and also propellers in temporary open area storage against the elements. Choose appropriate fabrics and materials that can be broken down immediately prior to shipboard equipment operation and requires a minimum amount of shipboard storage space.

PHASE II: Fabricate and test several systems onboard naval ships and at naval open area storage locations for a variety of factors including wind, rain, snow, ice, sand, ozone, aging, etc. to fully determine its effective range of performance. Perform internal humidity and atmospheric tests in several military environments, such as marine, desert, jungle and arctic, to determine its corrosion preventative capability potential. Storage systems for shipboard applications should also be constructed and tested for reduced radar cross section attributes. Compare findings to current methods of temporary storage.

PHASE III: Development of these products can benefit the Coast Guard, Army, Marines, and Air Force. Each service has many items stored in an open area that require constant upkeep and monitoring to insure equipment longevity. Any increase in shelf life will cut preservation and logistics costs, conserving military maintenance dollars.

COMMERCIAL POTENTIAL: Storage systems that protect against corrosion and other harmful effects have commercial applications in the commercial marine, cruise ship, off-shore oil platform, and manufacturing industries for use in protecting items from an aquatic environment.

KEY WORDS: Storage; Shelters; Synthetic Fabrics; Corrosion; RADAR Absorbing; Enclosed Environment

N99-116 TITLE: Precision Automatic Landing System

SCIENCE/TECHNOLOGY AREA: SensorsSensors, Electronics, and Battlespace Environment (DTAP-5)

OBJECTIVE: Design, construct and operate a ILS and precision automatic landing system for aircraft carriers that is at least as functionally equivalent to the currently proposed upgraded Automatic Carrier Landing System, the ACLS+. In addition, it must have the following enhancements: (1) uses technology that will not allow the identification of the ship as an aircraft carrier, (2) requires little or no modifications to the aircraft, (3) will not require topside ship board equipment with radar cross section greater than 1 square meter.

DESCRIPTION: The Navy plans to build a new class of aircraft carriers, presently designated as CVX, which will employ stealth technology. The present system used for ILS (Instrument Landing System) and automatic carrier landings does not easily lend itself to this requirement. A new,all service system, the Joint Precision Approach Landing System, JPALS, does meet this requirement. However, JPALS is GPS based and therefore depends on the presents and proper functioning of the GPS satellites. In a battlespace, these satellites may very well be disabled, thus causing this system to fail. The ACLS+ could operate in this battlespace environment, but as mentioned above, does not meet the desired signature requirements. What is sought is a secondary or back up system that meets all of the requirements. This system would support programs in PMS312 and PMS 378.

PHASE I: To develop and demonstrate, at least by detailed modeling, an innovative and practical ILS and automatic carrier landing system with the above capabilities.

PHASE II: Implement the innovation, which shall include the design and testing of a prototype system. Explore major cost and reliability issues associated with the technology in the context of both military and commercial viability.

PHASE III: Integrate the approach into emerging CVN77 and CVX architectures.

COMMERCIAL APPLICATION: JPALS is based on, and compatible with, the new commercial Free Flight Air Traffic Control system. Therefore the commercial community will have the same vulnerably to satellite failure as the military. Hence this proposed secondary system will provide a reliable back up for them as well.

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KEY WORDS: CVX; JPALS; ACLS; GPS; NAVAIR, ATC

N99-117 TITLE: Linear Motor Technology in the Vertical Plane.

SCIENCE/TECHNOLOGY AREA: Mechanics

OBJECTIVE: Advance linear motor technology for use in moving high-end loads in the vertical and horizontal planes, and transitioning between the planes.

DESCRIPTION: Conventional handling of cargo and weapons aboard ship requires multiple conveyances (forklift trucks, conveyors, elevators, dumbwaiters, etc.). Time and manpower are consumed transitioning loads between the various conveyances. An integrated system that could move material throughout the ship, both horizontally and vertically, is highly desirable. Such a system would require a third less manpower to operate and maintain than the multiple machines and multiple transitions currently used. The rapid deployment of weapons from supply ship to battle group and from magazine to aircraft, gun or assault vehicle would be enhanced. Linear motor technology is the method envisioned through which such a system could be realized. The development of this technology to enable a linear motor driven device to safely and efficiently move loads in the vertical plane and transition the load to and from the horizontal plane is the goal of this project.

PHASE I: Design and develop a linear motor driven device capable of loads up to 12,000 lbs, and employ multiple lifting platforms. Conduct and report design studies of existing and developmental linear motor technology and concepts and transition the horizontal based technology to vertical application. Explain in detail the selection of concepts, materials and components to be used in Phase II will be addressed.

PHASE II: Develop a working model, scaled in size to facilitate mounting on a ship motion simulator. The model will demonstrate the successful implementation of linear motor technology and concepts to simultaneously move multiple loads within a single trunk in both the vertical and horizontal planes and transition those loads between the two planes.

PHASE III: Develop a full scale model to be used as a land based test site through support of the Advanced Technology Demonstration or other DoD sponsored program.

COMMERCIAL POTENTIAL: Cableless elevator systems are envisioned for the 21st century high rise buildings. Conventional elevators in high rise buildings are restricted by the limitations associated with wire rope and the inefficient use of space and excessive waiting time associated with a single car system. Architects of super high rise buildings envision future building heights that far exceed the buildings that exist today. The limits of the conventional elevator are one of the major obstacles confronting these designers. A linear motor driven elevator system could allow multiple cars in a single hoistway.

REFERENCES: Hiroshi Kamaike, Toshiaki Ishii, Eiki Watanabe and Yoshitaka Matsukura, Mitsubishi Electric Corp., "A Ropeless Linear Drive Elevator", Elevator World Magazine, March 1991.

KEY WORDS: Aircraft Carriers, Cableless Elevator; Linear Motor; Material Handling; Linear Drive; Hoist

N99-118 TITLE: <u>Innovative Solutions to Improve Combat Information Center Operations</u>

SCIENCE/TECHNOLOGY AREA: Command, Control and Communications

OBJECTIVE: Reduce manpower requirements for Carrier Combat Information Center operations.

DESCRIPTION: Innovative techniques and methods are needed to reduce the manpower requirements for Combat Information Center (CIC) operations. CIC operations today, which involve collecting, processing, evaluating, displaying, and disseminating data, are manpower intensive. Planned enhancements to shipboard communication connectivity and networking within the battlegroup as well as enhanced ship to shore communications will enable high order of improvements to traditional CIC processes. Areas of interest include, but not are limited to: intelligent integration of information from multiple sensors using extended methodologies for designating target location and identification; CIC process/procedural improvements that leverage advances in connectivity/networking and focus on increasing the effectiveness of CIC operations; leading edge technologies in the areas of optics and digital video processing; innovative approaches for enhancing visualization of realistic images of objects/targets within the simulated battlespace.

PHASE I: Develop an innovative technique, method, or concept of operations that improves existing Carrier CIC processes. Define the procedures/methods and equipment required for the process improvement; identify associated workload reduction; and develop an implementation strategy to demonstrate the innovation.

PHASE II: Demonstrate the new concept by developing a land-based prototype, maximizing use of advanced computer simulation technology to demonstrate the concept.

PHASE III: Demonstrate the new concept on a selected ship

COMMERCIAL POTENTIAL: This technology has potential application to commercial air traffic control and operations.

REFERENCES: CV/CVN Combat System Orientation & Management Guide, CSE (CV/CVN)-86-1 (Rev 2), September 1992

KEY WORDS: MANPOWER, INFORMATION, VISUALIZATION, CIC, CONNECTIVITY, NETWORKS

N99-119 TITLE: High Strength (120-150ksi yield) Corrosion Resistant Fastener Material

OBJECTIVE: Develop and certify a high strength corrosion resistant fastener material

DESCRIPTION: Multiple programs have identified a need for certified high strength (120-150ksi yield) corrosion resistant fastener materials. The currently certified material, K-monel, is unacceptable for critical applications due to problems with galvanic incompatibility with more noble alloys, hydrogen embrittlement, and slow strain rate embrittlement. Also, K-monel has only been certified for use at 90ksi. Recent tests data indicate that many of the coatings (such as cadmium, which is also hazardous) used on high strength steel fasteners breakdown in as little as two weeks in the marine environment. Standard fastener materials used in the commercial marine environment have not been certified to meet many of the additional requirements of the Navy, such as Impressed Current Cathodic Protection System, Shock, and Space and Weight limitation. The Navy has developed a Material Selection and a Fracture Toughness Review Process to ensure that materials selected will meet these demanding requirements. All new materials or existing materials used in new applications shall be selected in accordance with the procedures outlined in these documents.

PHASE I: Select a promising alloy or process to be used as the basis for developing the high strength fastener material. Candidate fastener materials must be compatible with the Titanium and Inconel alloy families, when used in a naval marine environment.

PHASE II: Develop and certify the process or alloy and conduct testing to verify that the process is reproducible. It is also desirable to minimize/optimize production costs such that they are approximately the same as for K-monel.

PHASE III: Develop appropriate specifications/documentation to make the system standard in the Fleet These fastener materials will be useful for Naval applications such as foundation bolting for heavy deck equipment (e.g. Boat Davits, Elevators), submarine hull integrity fasteners and other submarine applications where strength is paramount and space and weight are critical. These fastener materials would also be used as replacement for existing marginal designs, which currently require periodic monitoring to ensure satisfactory service.

COMMERCIAL POTENTIAL: These fastener materials will be useful to the commercial marine industry for applications such as off-shore oil rigs, submersibles, shipyard cranes, etc.

KEY WORDS: Fastener; Corrosion Resistant; 120-150ksi Yield; Material Certification

N99-120 TITLE: Water Scale Deposit Removal: Faster, Environmentally Safer and Lower Cost

SCIENCE TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: To develop a low cost water scale, rust and lime removal chemical safe enough for daily shipboard maintenance that is non-hazardous, non-corrosive, non-toxic and is biodegradable. This chemical will increase equipment efficiency, decrease machinery cleaning man-hours, significantly reduce acid HAZMAT handling and save every ship maintenance dollars.

DESCRIPTION: Normal build-up of scale occurs in every water-cooled/heated piece of equipment over a period of time inevitably affecting many ship system efficiencies due to insulating the heat transfer flow. Hard scale deposits, consisting of calcium sulfate, calcium hydrate, calcium silicate, and iron oxide, inside water operated machinery, heat exchanger tubes and piping systems usually demand high pressure hydroblasting or even removing the equipment for shipyard chemical cleaning with hazardous acid. Safety and Naval operational constraints can prevent equipment removal or use of acid cleaning. A family of products is required that can be utilized far more effectively than removing equipment and subjecting it to an acid cleaning or hydroblasting. Chemicals should be made safe enough to hold in your hand and be capable of disposal in concentrated, unused form down regular sewer systems with a fresh water flush, minimizing costly HAZMAT disposal requirements. The chemicals must be compatible with metals found in shipboard water-cooled/heated systems and be used at nominal room temperatures. Required shipboard personnel protective equipment must be minimized and no hazardous vapors expended during use, allowing normal shipboard ventilation. The chemicals must breakdown the water scale, lime and rust buildup to a consistency no greater than coarse sand and eliminating clusters of solid particulate settling in machinery elbows or pipe bends that would restrict flow subsequent to the cleaning. After descaling, machinery efficiency should be at least 95% of the normal operating parameters.

PHASE I: Compile data, conduct tests and demonstrate the feasibility of an inexpensive chemical that is non-toxic, non-flammable, non-corrosive, non-hazardous and is biodegradable that will remove water scale (calcium sulfate, calcium hydrate, and calcium silicate), rust and lime buildup from shipboard machinery, to include: diesel engines, distilling plants, heat exchangers with associated piping systems, and seawater storage tanks. The chemical must be safe enough to use onboard a ship by trained sailors and be capable of disposal in unused form, devoid of neutralizing agents, following local regulations or discharged overboard while the ship is deployed. Also, develop a lightweight portable, chemical flushing unit to be used with the chemicals and stored in a minimal amount of space onboard a vessel.

PHASE II: Build two portable pump systems, create a test and evaluation plan, and test onboard selected Naval vessels on each coast. Develop a simple written process to clean and flush entire shipboard water-cooled/heated systems with chemical. Develop procedures and determine periodicity and cleaning requirements for each major piece of water cooled/heated equipment for individual ship classes. Requirements based on reduced efficiency due to internal blockage from scale buildup. Expand chemical cleaning development for use on entire CHT (Collection, Holding and Transfer) systems, radar water cooling systems and nuclear submarine water systems.

PHASE III: Use the data gathered to present at conferences and incorporate procedures into the U.S. Coast Guard vessels, USNS ships, Foreign Military Ship Sales Program, research vessels, Naval shore based boilers/power plants, and water cooling towers.

COMMERCIAL POTENTIAL: Commercial shipping also uses water to cool/heat equipment and requires descaling procedures. Using a 'safe acid' can enhance industry environmental compliance by allowing flushing down sewer systems. By using this chemical, many tens of thousands of dollars per commercial ship will be saved by not having downtime and dry-docking due to routine machinery scale buildup cleaning. Offshore oilrigs can also benefit by using the chemical regularly to clean water operated devices. Furthermore, the U.S. Army Corp of Engineers could benefit from this chemical's use by helping the organization remove and control Zebra mussel populations that infest river/ocean inlet piping for inland waterway utilities since the shells are calcium based and would erode similar to water scale.

KEY WORDS: acid; descaler; biodegradable; non-toxic; non-hazardous; non-corrosive

N99-121 TITLE: Sewage discharge pumps

OBJECTIVE: To provide a more reliable sewage pump that will also eliminate the need for having comminutors installed in the sewage system.

DESCRIPTION: Sewage pumps on present U. S. Navy ships are simply discharge pumps and are high maintenance drivers. The system requires communitors (also heavy maintenance burdens) to chop the solids into small enough pieces to pass through the pumps. A reliable pump is needed that chops the solids and discharges the fluid overboard or to the existing deck risers to offload the fluid.

PHASE I: Research and define requirements for a more reliable/maintainable CHT pump. The new pump must be able to chop solids and pump the waste off the ship without the need of a communitor.

PHASE II: Design and fabricate a prototype pump onboard a selected ship for evaluation. Develop a test plan for evaluation of the prototype pump, including pass/fail criteria.

PHASE III: Develop different size pumps to accommodate most if not all pump requirements for U. S. Navy ships. This technology should be developed to meet the capacity/discharge requirements of all PEO EXW ship classes. The same technology would then be available to other PEO's ship classes and utilized throughout the NAVY. The design would then be available to any NAVSEA/PEO Program Manager or Type Commander to pay for the construction of pumps needed to fulfill the discharge capacities for their ships.

COMMERCIAL POTENTIAL: This pump can be utilized in U. S. Coast Guard, MSC and commercial ships for disposal of sewage.

KEY WORDS: Sewage pump; macerator; sewage ejection pump

N99-122 TITLE: Total Ship Training Concept

SCIENCE TECHNOLOGY AREA: Training

OBJECTIVE: Develop innovative concepts and techniques for integrating legacy and new development shipboard trainers and training models in a crew/embarked Marines mission training environment

DESCRIPTION: Recent developments in Navy shipboard training programs such as Battle Force Tactical Trainer (BFTT) have revolutionized the manner in which we train our crews in combat systems employment. BFTT utilizes advanced distributed modeling and simulation techniques in concert with a cognitive learning model to optimize team performance. Other shipboard training systems and trainers for embarked Marines are utilized in a stovepipe fashion to train their operators in systems such as Damage Control, Air Traffic Control, Combat Vehicles and Machinery/Ship Control. In the real world the systems and operators that these trainers represent are tightly coupled and highly dependent on each other's condition and actions as a result of operational decisions and battle damage. Total ship/force performance can be greatly improved by developing innovative techniques for netting these disparate training systems together in a team-training environment.

PHASE I: Develop innovative Training concept of operations, provide an architecture for interactive utilization of selected trainers and identify likely shipboard and Fleet Marine Force training system candidates to receive this tehcnology.

PHASE II: Develop a prototype Total Ship Trainer demonstrating the openness of the chosen architecture and the training value added for ships company and embarked Marines of the interaction between the trainees.

PHASE III: Build upon the architecture developed and demonstrated in PHASE I & II to develop and produce a Total Ship Training environment for New ship classes and apply the architecture to existing ships as a back-fit program.

COMMERCIAL POTENTIAL: Many industries rely upon stovepipe trainers to hone the skills of individuals operating within limited functional responsibilities. Commercial power plants, Air Traffic Control, large manufacturing plants, etc. can benefit from this technology by training the entire work force in a netted/distributed fashion.

KEY WORDS: Team Training; distributed simulation; cognitive learning; open systems; reusable software; trainers

N99-123 TITLE: Corrosion Preventative Methods for Structural Steels

SCIENCE TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop and demonstrate new methods of corrosion prevention for structural materials allowing the metal to remain in open outside storage areas minimizing any corrosion or oxidation.

DESCRIPTION: Corrosion has been an extraordinary problem for the Navy as well as industry for many years. Building a Naval ship requires several years of construction with months of lead-time for structural components. Many of these components may lay for weeks in open areas exposed to the elements and begin to rust and corrode before final fabrication and installation aboard the vessel. Removal of corrosion and reconditioning the metal adds many man-hours of work and increases construction cost. Recent developments in metallurgy and related commercialization efforts have opened new possibilities to combat corrosion in structural materials that could allow the metal to remain free of corrosion from initial metal manufacturing through final fabrication, assembly and painting.

PHASE I: Develop a new metallurgical process for corrosion prevention of structural steels. Analyze the results to preliminarily determine the corrosion preventative potential of this new process and demonstrate the feasibility to use this process on shipboard metals.

PHASE II: Apply the corrosion inhibiting process to low/high carbon, mild, ordinary-strength, HY-80, HY-100, HY-130, high-strength low-alloy (HSLA) steels and other structural alloyed steels. Test for a variety of factors including weldability, fatigue resistance, ease of use in construction, and abrasion resistance to determine the general applicability for such a process to be used for structural metals. Evaluate the process to determine use in piping systems, and seawater storage tanks. Perform Salt Spray and other corrosion tests on these metals treated in this new process. Evaluation to include a shipboard phase and written report of findings. Investigate design of a portable corrosion inhibiting application unit that can treat welds and other untreated metal added that are a result of repairs. Evaluate the process for use on weapon mounting systems, LCAC aluminum structures and submarine manufacturing metals.

PHASE III: Shipyards and Naval facilities will participate with the small business concept developer to investigate transition of the metallurgical process technology into a large scale production processing facility constructed in the vicinity of major steel manufacturer's to minimize costs associated with transportation of metal and relieve deterioration due to open area storage.

COMMERCIAL POTENTIAL: The process developed under this topic has performance potential in common with corrosion inhibiting requirements of the Coast Guard, Army, Marines, Air Force, commercial ocean freighters, and cruise ship fleets. The field of corrosion prevention is also broad enough to apply to many industries including: automobile, appliance, aerospace, farm implements, oil, and many others.

REFERENCES:
1. American Bureau of Shipping, Rules for Building and Classing Steel Vessels, New York, 1978.
2. Fink, F.W., and W.K. Boyd, The Corrosion of Metals in Marine Environments, Defense of Metals Information Center, Columbus, Ohio, 1970.
3. LaQue, F.L., Marine Corrosion Causes and Prevention, John Wiley & Sons, New York, 1975.

KEY WORDS: corrosion; metallurgy; metals; metallurgical process; structural materials; rust

N99-124 TITLE: Microwave Technology Treatment for Sewage System

SCIENCE/TECHNOLOGY AREA: Environmental Science

OBJECTIVE: To provide a treatment system for sewage and gray water

DESCRIPTION: Recent developments in industry have proven that sewage and gray water can environmentally be handled with microwave technology. This technology can and should be adapted to shipboard use. Presently, ship's collect, hold and then transfer off the ship all their sewage and gray water without treatment. In port the ships discharge the waste to pierside connections, at sea they discharge sewage overboard and gray water from most locations drains overboard.

PHASE I: Design an applicable waste treatment system to handle sewage and gray water waste streams to eliminate sludge and produce an effluent that is environmentally safe to discharge overboard.

PHASE II: Build and install on a ship the new microwave treatment facility to handle all the sewage and gray water streams in an environmentally safe manner.

PHASE III: Develop installation guidance for shipboard installations for all classes of U.S. Navy ships. Develop strategy for the expansion of this technology into the Solid waste, Medical waste, hazardous waste and any other applicable waste shipboard streams.

COMMERCIAL POTENTIAL: This system can be utilized in residential and commercial markets.

KEY WORDS: Microwave; Extraction; Microwave incineration; membrane technology

N99-125 TITLE: Advanced Verification and Validation Techniques

SCIENCE TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop verification and validation (V&V) techniques applicable to complex models and simulation systems.

DESCRIPTION: The improved availability of processing power has brought a revolution to modeling and simulation. It is now possible to employ extremely complex dynamic algorithms in the simulation of reality. These algorithms typically involve interdependence of several variables and offer better fidelity than simple algorithms. However, our ability to simulate complex behaviors and scenarios has outpaced our ability to clearly define the bounds of conditions under which these simulations accurately reflect the real world. New methods are required for determining and describing the degree to which intricate simulations emulate reality.

PHASE I: Define metrics which identify critical aspects which models or simulation must address to provide a sufficient representation of reality for specific purposes. Identify potential approaches for quantifying model or simulation performance against such metrics.

PHASE II: Develop and document the quantifying techniques identified in PHASE I. Apply these techniques to at least two behavioral models and/or large simulation systems to demonstrate their utility.

PHASE III DUAL USE APPLICATIONS: Once developed and tested, these techniques will be employed in establishing and defining the validity of all new simulations. Beyond application to modeling and simulation, methods that define the validity of multi-variable processes have widespread DoD applications. The effectiveness of Tactical Decision Aids that must consider several interdependent variables could, for example, be evaluated. The ability of a combat direction system to produce desired results under extreme or unusual conditions could also be defined using the techniques developed under this effort.

COMMERCIAL POTENTIAL: Simulated manufacturing is becoming more prevalent in the commercial world. The models used in this context continue to become more detailed and complex considering the cost and schedule interdependencies of such things as work flow, parts ordering and delivery, retooling, and staffing level per shift. The accuracy and limits of these models must be verified if sound business decisions are to be made. Additional Commercial applications are possible in the measurement of effectiveness of a national distribution system, airline utilization of aircraft, or a communications network switching system.

REFERENCES:

1.) Department of Defense Policy Instruction 5000.61, November 1996

2.) Department of Defense Verification, Validation, and Accreditation Recommended Practices Guide, November 1996

KEYWORDS: Verification; validation; modeling; simulation; performance; metrics; multivariable analysis

N99-126 TITLE: Modeling and Simulation (M&S) Environment Server for Distributed/Embedded Environment Representation

SCIENCE TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: The objective of this effort is to develop an environment data and effects server which can serve out a consistent environment representation when implemented as a distributed application or as embedded components.

DESCRIPTION: There is a need for all the components of a simulation that use parameters describing the natural environment (weather, sea state, etc.) to receive environment data and calculate environment effects consistently. Existing approaches have focused on a centralized software server that provides all the environment parameters for simulation components. However, many distributed simulation implementations require the capability to calculate environment effects locally, to relieve bandwidth congestion or satisfy security concerns. In addition simulations which use legacy models often have environment calculation routines embedded within the simulation.

PHASE I: The contractor will develop a design for a synthetic environment data and effects server capable of operating as a distributed implementation, and capable of controlling embedded environment calculation routines.

PHASE II: The contractor will develop a prototype capability and demonstrate the prototype in conjunction with a related demonstration of an M&S system.

PHASE III: The contractor will mature the prototype system and develop supporting documentation that describes system installation, configuration and operating procedures.

COMMERCIAL POTENTIAL: A software application of this type could be sold commercially to developers of M&S systems as a helper application or component.

KEY WORDS: M&S; environment; server; prototype; distributed; embedded

N99-127 TITLE: Object Resolution Mapping

SCIENCE TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop schemes for the mapping of objects from a simulation at one resolution to a simulation at a different resolution.

DESCRIPTION: Within the framework of the Defense Modeling and Simulation Office's High Level Architecture (HLA), data is exchanged between simulations in the form of objects. To efficiently represent large scale operations in simulations and yet retain the ability to investigate portions of the battle space in detail, it will be necessary for simulations at fundamentally different levels of resolution to operate with each other. In order to do this, there must be consistent and verifiable methods of mapping the information within the simulation at one level of resolution to the information required by the simulation at a different level of resolution.

PHASE I: Identify possible schema for the correlation of data of different levels of detail between simulations. Estimate the feasibility of employing each scheme in simulation exercises. Design implementations of the most promising of these schemes.

PHASE II: Produce a limited implementation of the designs produced in the first phase. Demonstrate the viability of the designs by facilitating the moderate interoperability of two simulations of different levels of detail.

PHASE III: The new generation of communication systems will be object based. Effective operation of multiple systems within this architecture requires that these systems share a common and unambiguous interpretation of each object. Such a shared interpretation is unlikely for communication systems independently developed by different services, different contractors, and for different purposes. To ensure compatibility between systems, an object mapping scheme will be required.

COMMERCIAL POTENTIAL: Many commercial systems use the construct of objects for information transfer. The object mapping schemes developed by this effort could allow for systems using disparate object definitions to communicate with each other.

REFERENCES:
1.) Department of Defense Modeling And Simulation (M&S) Data Administration Strategic Plan (DASP), April 1996 at Internet http://www.dmso.mil
2.) Department of Defense Modeling and Simulation (M&S) Master plan, October 1995 at Internet http://www.dmso.mil
3.) Information on the High Level Architecture and modeling and simulation data standards can be found at the Defense Modeling and Simulation Office web page at http://www.dmso.mil

KEYWORDS: Resolution; data objects; HLA; correlation; simulation.

N99-128 TITLE: Battle Group Measures for Assessing Training and Readiness

SCIENCE TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop a technical framework to link Navy Mission Essential tasks to tactical training curriculum for assessing training effectiveness.

DESCRIPTION: Battle Group training involves exposure to the complex set of options of command and control that optimize the fighting capability of hardware/software systems, people and tactics needed to execute mission essential tasks. The mission essential tasks as specified in the Universal Navy Task Lists (UNTLs) identify those tasks to be performed and the conditions under which they must be performed. Training the fleet involves both instructing "What to do" and "How to do it" for those essential tasks, and then the actually doing of those tasks in live training exercises. The UNTLs do not reflect "who" is to do the task nor "how" the task is to be performed. "Who" does the task is generally defined in a concept of operations (CONOPS) and the "how" the task is conducted is contained in the myriad of tactics and doctrine that can be chosen by a commander. The measures of performance listed in the UNTLs are outcome based, and therefore are not sensitive to tactics or who performs the task. For training to be effective, the task must be understood, the proper tactic chosen and the doer must properly perform the task and tactic. The selection of a course of action by a commander is typically based on his/her previous discovery and familiarity in decision making, which may not be the optimal solution for the given situation. Consequently exposure to all tactical situations possible during the training experience will expand the range of response and will lead to the chance of a more optimized tactical choice to counter the tactical behavior of the opposing forces.

Consequently, for Fleet training to be effective there must be a realization of the wrong course of action and a realization of the conditions for selecting the right course of action. Consequences of right and wrong courses of actions must be fed back to the trainee in rapid after action reporting to impart full realization of decisions made and actions taken.

Achieving the desired result from Battle Group command and decision training is only possible if the Navy Mission Essential Tasks are linked to the tactic/doctrine being employed and that in turn is linked to the proper procedure for the expected environmental conditions. The tactics chosen are the prerogative of a commander who assesses the battle situation for the conditions of the tactic. There may be several tactics that could apply, but knowing which to choose and command as the optimal one at the right time, should be significant part of training. Tactics are accompanied by procedures that must be implemented for an effective tactic. The environmental conditions under which the task is to be executed, such as at night, at -10 degrees Fahrenheit with a 35 knot south wind, and sea state 3 in moderate rain is critical to understanding applying the proper tactic to the task. Consequently, the minimum essential data needed to measure performance and effectiveness of the training must include the task, the doer(s) of the task, the conditions of the task, and the tactics and procedures chosen.

No framework exists or cognitive method or training tool or aid exists today that links tactics and conditions to the Navy Mission Essential Task Lists (NMETLs) or Universal Navy Task Lists (UNTLS) for training use. The training methods today focus on understanding processes and do not incorporate battle group measures of performance/effectiveness outcomes. The published UNTLs measures are predominately outcome-based measures, but do not incorporate the doer and the tactics with the conditions. Consequently these measures by themselves have little relevance for assessing whether a minimum standard of proficiency in executing the specific task list was achieved.

PHASE I. Develop an appropriate new method for linking the UNTLS with tactics, conditions and procedures into a tactical training tool or aid that can be integrated into the Navy's JSIMS Maritime and BFTT programs. The performance of a trainee must be measurable. Therefore, this phase will propose associated measures of performance and effectiveness and asociated data collection sources in order to quantify the value of the training aid. Example performance measures of interest include the gain in performance from taining applications that integrate use of tactics into mission tasking at varying levels of war.

PHASE II will focus on proto-typing the technical framework for one warfare area from PHASE I into a training aid. This phase will also demonstrate the functioning of the tool in a selected set of training events utilizing the performance measures proposed in PHASE I. This phase will focus on the application in a real training event, collecting data to produce the performance measures and providing feedback of the measures to the trainee for comparative analysis of this approach toward improving training over the current training approach.

PHASE III. This phase will result in the integration and implementation of the training assessment technical framework and after action review techniques within BFTT and JSIMS Maritime programs. Included will be defining and integrating of requisite data collection and data processing methods, and the creation of rapid feedback displays of the evaluative measures within the training environment of BFTT and JSIMS

COMMERCIAL POTENTIAL. This innovative research technology will have the potential for the commercial market to provide improved training approaches to all aspects of civil, government, and military planning, crisis management and training.

KEY WORDS: Technical framework, training, performance assessment,

N99-129 TITLE: QoS Optimization Tool for the Internet Protocol (IP) Based Integrated Services Internet

SCIENCE/TECHNOLOGY AREA: Command, Control and Communications

OBJECTIVE: To develop a QoS optimization tool, including a set of traffic control functions and realistic delay bound scheme, to optimize bandwidth allocation such that network utilization can be enhanced by as much as 50% while maintaining Quality-of-Service (QoS) commitment in the IP-based Internet.

DESCRIPTION: The traffic demand on the IP-based Internet is continually increasing. Such demand includes two fundamental challenges: greater bandwidth and higher QoS commitments. They often conflict with each other. The Internet Engineering Task Force (IETF) has developed a suite of standards to provide QoS transport over IP-based networks. These standards fall under the umbrella of Integrated Services (Int-Serv), which is particularly well suited to emerging real-time, multimedia, and multicasting applications.

At the heart of Int-Serv, packet delay is the key requirement to providing the desired QoS objectives. Usually, it uses a conservative bandwidth allocation approach, which is based on theoretical worst-case traffic behavior. As such, the end-to-end delay bound is hard bound or set at the maximum and unchangeable limits. In this approach, the utilization of bandwidth is quite low, since the actual delay is often much less. How to maximize the entire network utilization while keeping QoS commitments in the Internet is an open and important question

The solution may include the investigation and development of new algorithms or methodologies that can determine the realistic delay bound instead of the hard delay bound by considering accurate traffic models and statistic multiplexing. The realistic delay bound and aggregate traffic conditions should be dynamically and accurately reflected in assessment of the existing traffic load and bandwidth allocation for upcoming traffic requests.

To achieve QoS goals, critical traffic control functions shall be reviewed and proposed, such as packet scheduling, packet dropping, packet classification, and admission control. Altogether, the outcome will be a QoS optimization tool, which will result in a higher network utilization rate by as much as 50% while satisfying service objectives

PHASE I: Develop a preliminary working prototype of IP QoS optimization tool, including traffic control functions with a realistic end-to-end delay bound scheme, to prove the feasibility of optimizing both bandwidth utilization and QoS. Complete a trade-off analysis between vendor-implemented delay bound schemes and IP QoS commitments, and continue toward Phase II.

PHASE II: Develop a complete tool, incorporating IP traffic control functions and the end-to-end delay bound scheme, that can optimize the above network parameters and maximize the IP network usage and QoS delivery. Prototype the proposed solution on the simulation platform that can meet the stated objectives and integrate it with a Navy-selected network-vendor's platform.

PHASE III: Integrate the software products with an actual IP-based network in the Navy shipboard environment.

COMMERCIAL POTENTIAL: Many industrial/commercial activities would use, and benefit from the use of, this innovative technology. Examples are organizations that require real time, multimedia and multicasting applications to be transported over the Internet with a QoS requirement for bandwidth and IP services. The proposed solution will conform to the open Int-Serv structure. Hence, besides military applications, it will have dual use applications in the commercial sector. The proposed solution can also be deployed as a key component of the Internet Engineering Task Force Int-Serv QoS package for the upcoming Internet upgrade.

REFERENCES:

1. RFC 1633, AIntegrated Services in the Internet Architecture: An Overview, July, 1994.
2. RFC 2205, AResource ReSerVation Protocol (RSVP) Version 1 Function Specification, September 1997.
3. RFC 2212, ASpecification of Guaranteed Quality of Service, September 1997.
4. RFC 2211, ASpecification of the Controlled-Load Network Element Service, September 1997.
5. RFC 2208, AResource ReSerVation Protocol (RSVP) Version 1 Applicability Statement Some Guidelines on Deployment, September 1997.

KEY WORDS: Network Utilization, QoS, IP, Internet, Integrated Service, Traffic Model

N99-130 TITLE: Navy Command System: A Quality of Service (QoS) Management Tool Over Internet Protocol (IP)-Based Networks

OBJECTIVE: Investigate the network characteristics of carrying voice, video, and multi-media applications over both wire and wireless IP networks for the purpose of developing a set of IP quality-of-service (QoS) management tools to facilitate end-to-end QoS provisioning.

DESCRIPTION: A critical issue in today's networking environment is how communication infrastructures (both wire and wireless) interoperate with TCP/IP protocols to provide a guaranteed, end-to-end Quality of Service (QoS) delivery. There is no standard approach for configuring QoS parameters; there are only vendor-specific implementations.

Guaranteed QoS is being recognized as the missing piece in the evolution of QoS-based service offerings in the Internet. Routing developed for today's Internet is based on IP protocols and typically supports only one class of service to users, called "Best Effort" routing. Best effort routing uses only the destination address to decide the routes, which is not a good way if multimedia traffic is to be routed. Multimedia traffic requires more strict specifications for their routes (e.g. delay and jitter).

To improve network performance and guarantee QoS delivery with IP protocols over both wired and wireless network infrastructures, it is proposed that an interoperability study of existing and emerging technologies be undertaken, using both real and simulated network traffic in a heterogeneous vendor environment. The results of this study will be used to develop a set of IP QoS management tools. The outcome of this study and the resultant management tools will assist the Navy and network service providers in configuring their networks to achieve quality of service guarantees while maximizing network utilization.

PHASE I: Phase I will be divided into two sub-phase efforts. First, a technical comparison of IP QoS standards published by the Internet Engineering Task Force (IETF) and International Telecommunications Union (ITU) with the IP QoS implementations of the major equipment vendors will be performed to analyze and document equipment standards conformance. Second, development of a preliminary working prototype of an algorithm (software) that will map IP QoS parameters into HP OpenView (a widely used Navy network management system) to prove the feasibility of managing IP QoS standards from a network management system platform and continue toward Phase II.

PHASE II: Develop management and provisioning characteristics and guidelines for IP QoS parameters in both wired and wireless environments. Develop and demonstrate a prototype of an IP QoS planning and management tool that can assist network designers in configuring more efficiently networks that consists of heterogeneous vendor equipment.

PHASE III: Test the QoS management tools in Navy shipboard environments on wire and wireless communication networks. Document the results of improvements in networks reconfigured using these tools.

COMMERCIAL POTENTIAL: Many industrial/commercial activities would use, and benefit from the use of, this innovative technology. Since IP QoS Management tools can provide QoS guarantees and network performance improvements in a heterogeneous environment, this will be of considerable benefit to manufacturers of switches and routers for increased thru-put. Commercial Internet Service Providers will be among the first to benefit from improved network performance by having available to them IP QoS management tools that insure quality transmissions of multi-media traffic.

KEYWORDS: IP Protocols, Quality of Service (QoS) parameters, network performance improvements

N99-131 TITLE: Simulation Based Acquisition Environment Development

SCIENCE/TECHNOLOGY AREA: Computer Science & Technology

OBJECTIVE: To research, design, prototype and demonstrate a collaborative, distributed data, modeling and simulation application environment capable of supporting the activities associated with complex systems acquisition.

DESCRIPTION: Systems engineers, designers, acquisition managers, functional area experts, and business managers face an unprecedented challenge in the capture, analysis and synthesis of information required to evolve systems from concept definition through development, deployment, and upgrade to retirement. Adding to this challenge, designers of these system products must meet the broad mission objectives within stringent budgetary constraints while satisfying performance requirements and schedule.

Simulation Based Acquisition (SBA) is a new acquisition paradigm which holds the promise of enabling the management of the product and process complexity inherent in major system acquisitions. SBA is embodied by three principals tenants: a virtually-integrated data, modeling and simulation environment; an iterative acquisition process which takes advantage of the that environment; and an evolved culture where enterprise-wide cooperation and integration is facilitated by the digital environment. SBA, and the underlying notion of an integrated enterprise digital acquisition environment is a key enabler to producing more expedient, higher quality Naval systems at unprecedented cost savings. This topic seeks to pursue a three-phased research program which will define, design and integrate the acquisition and engineering data objects and associated application objects within an SBA environment; define a data object model template (OMT) and a Object Database Connectivity (ODBC) interface for modeling and simulation applications; design and specify an Object Request Broker (ORB) communication architecture; specify an ORB Interface Definition Language (IDL) and services for an internet client/server computer and database management system communications infra-structure needed by SBA. Based upon the OMT, ODBC, ORB and IDL specifications, prototype and demonstrate a representative subset of acquisition, engineering, functional and business databases, models and simulation applications in an integrated SBA environment.

PHASE I: Research and develop a design specification for the essential OMT, ODBC, ORB and IDL infra-structure required to create an integrated information environment for SBA, using existent models and simulation applications.

PHASE II: Develop a functionally representative SBA environment prototype supporting the broad range of acquisition, engineering, functional and business processes.

PHASE III: Demonstrate, extend and deploy the SBA environment infra-structure in support of a broad variety of Naval and Defense acquisition programs, and commercial industry systems/products.

COMMERCIAL POTENTIAL: Trends in recent business enterprise management of complex system/product development indicate the growing need to integrate engineering design and development, manufacturing and production, and financial information, models and simulations in a seamless integrated data and applications environment. For example, the rise of Enterprise Resource Planning (ERP) products such as those from Iona, Baan, SAP, and PeopleSoft demonstrate that complex management structures require an advanced integrating infrastructure to support increased competitiveness and decreased time-to-market for such complex products as aircraft, communication systems, shipbuilding, vehicles, and space systems. A robust, extensible engineering data, modeling and simulation infrastructure capable of providing support to the engineering, functional and business management activities associated with developing such complex systems offers the potential to revolutionize the systems engineering tool market.

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KEY WORDS: simulation-based acquisition; modeling & simulation; acquisition; complex systems; systems engineering; affordability

N99-132 TITLE: Security Mode Verification for Untrusted Workstations

SCIENCE/TECHNOLOGY AREA: Command, Control and Communications

OBJECTIVE: Develop and demonstrate a method of externally and independently verifying that a group of networked workstations with embedded encryption and untrusted operating systems are configured properly.

DESCRIPTION: Future Navy ships will make use of workstations with untrusted operating systems, e.g., WindowsNT7 or Windows957, that handle classified information. The information will be protected via workstation-embedded encryption. However, due to the untrusted nature of the operating system, there is nothing to prevent the careless or malicious operator from reconfiguring the workstation so as to use an incorrect encryption algorithm, or to bypass encryption altogether. What is needed is some method of externally detecting that a workstation's security mode has been changed from a desired baseline configuration. The verification method should be implemented by some technique that cannot be bypassed by the workstation operator. The technique should support multiple security configurations on different workstations and the security configuration must be able to be verified even if it dynamically migrates as applications migrate from one workstation to another workstation.

The R&D technologies that might be exploited to meet the requirements of this topic include (a) Asmart agents residing on workstations that are capable of detecting changes in the security structure of the workstation, (b) special server software that can poll workstations and compare their security structure with a desired, baseline structure, and (c) high-performance network technology that can support rapid security client-server exchanges at a pace needed to keep up with dynamic application migration.

PHASE I: Develop the architecture of the security mode verification scheme and show (via paper analysis) that it cannot by subverted by the workstation operator. Develop an initial prototype of the architecture to establish its feasibility. Test the prototype and identify the improvements that will be needed during Phase II.

PHASE II: Extend the Phase I prototype to create a robust Phase II prototype demonstration model that incorporates the improvements needed from the Phase I baseline. Determine the performance of the innovation in terms of ease of setup and management by the security administrator. Explore major cost and reliability issues associated with the technology in the context of commercial viability.

PHASE III: Productize the innovation for use in military and industrial/commercial applications. Typical military applications include the DD-21 ship class and any ship being upgraded with a multilevel security network and workstations with an untrusted operating system .

COMMERCIAL POTENTIAL: Many industrial/commercial activities would use, and benefit from the use of, this innovation. Examples are organizations that require high security but do not use trusted operating systems for cost or ease-of-use reasons, e.g., organizations that perform electronic funds transfer, organizations that have closely-held trade secrets, etc.

KEY WORDS: security; encryption; untrusted-workstations; configuration-verification; untrusted-operating-systems; security-monitoring

N99-133 TITLE: Performance Interoperability in Internet Protocol/Asynchronous Transfer Mode (IP/ATM) Networks

SCIENCE/TECHNOLOGY AREA Command, Control and Communications

OBJECTIVE: Investigate the performance interoperability in IP/ATM networks with heterogeneous vendors' products. Develop a simulation tool based on OPNET to facilitate seamless interoperability of the networks such that end-to-end network performance will not be downgraded and can be optimized in multi-vendor environment.

DESCRIPTION: Different network equipment vendors provide proprietary networking solutions to local area networks (LANs), wide area networks (WANs), asynchronous transfer mode (ATM) networks, synchronous optical networks (SONETs), and to the Internet. How their products (such as switches, routers, bridges) can be made to cooperate to provide end-to-end quality-of-service (QoS) guarantees becomes a critical issue in today's shipboard networking environment.

As an example, vendors like Cisco, Bay Network, and Cabletron have proposed and implemented various scheduling policies, such as weighted fair queuing (WFQ), earliest due date (EDD), and strict priority queuing. Combined with various buffer management schemes, such as random early detection (RED), weighted RED (WRED), early packet discard (EPD), partial packet discard (PPD), dynamic threshold, and longest queue push-out, they provide an integrated service solution with different QoS requirements (delay-sensitive, loss-sensitive, etc.). Deploying multi-vendor equipment in Navy shipboard networks with different combinations of these QoS implementation schemes can have distinct impacts on network performance and utilization.

An investigation is needed to examine how vendor implementation of IP QoS can interoperate with one another. A determination needs to be made as to whether the network performance will be downgraded in a multi-vendor network environment as opposed to a single vendor network. Also a determination needs to be made as to how can we optimize the performance of multi-vendor networks. A complete set of OPNET simulation models shall be developed based on the framework of the performance interoperability study to help the Navy or network service providers configure their networks to achieve network performance optimization. The simulation tool shall include models for equipment, protocols and traffic source types, which are used by the Navy. The model development shall conform to the standards of Network Warfare Simulation (NETWARS).

PHASE I: Identify problems and issues regarding the QoS implementation in heterogeneous IP/ATM networks. Develop a preliminary working prototype of interoperability-optimization algorithms to prove the feasibility of using these algorithms to configure a heterogeneous network and continue toward Phase II.

PHASE II: Develop interoperability-optimization algorithms or guidelines for heterogeneous network configuration. Prototype a simulation tool incorporating interoperability-optimization algorithms, that can assist network designers in configuring their networks in a heterogeneous vendor-equipment environment.

PHASE III: Demonstrate, extend and deploy the simulation tool in the entire NETWARS environment and commercial OPNET environment to enhance the network interoperability performance in the broad scope of military networks and the commercial industrial networks.

COMMERCIAL POTENTIAL: Many industrial/commercial activities would use, and benefit from the use of, this innovative technology. Many vendors who manufacture ATM equipment for LANs and WANs do not cooperate to provide a capability for Quality of Service when multiple vendors equipment are used in the same installation/environment in many cases today. This is a critical issue to the Navy, since we use all COTS equipment within a mixed vendor environment of installed equipment for our shipboard networks. For example, if this set of simulation tools were available today, we could install network components together from multiple vendors and be able to operate our network with a maximum QoS and efficiency. The first to benefit from this technology besides the military, would be the network equipment manufacturers being able to for the first time provide a really true QoS Capability for ATM network equipment in mixed vendor installations and be more fully compatible with each others hardware. Existing and future commercial network systems could be made to be more interoperable, and provide more bandwidth and a higher quality of service with the assistance of these simulation tools.

REFERENCES: A Research Challenges for the Next Generation Internet., Edited by Jean E. Smith and Fred W. Weingarten, Computing Research Association, May 12-14, 1997.

KEY WORDS: QoS, Interoperability, IP/ATM, Internet, Fair Queuing, Buffer management

N99-134 TITLE: <u>1300nm Vertical Cavity Surface Emitting Lasers (VCSELS)</u>

SCIENCE/TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop a new class of long wavelength VCSELS operating at 1300nm

DESCRIPTION: Current commercial and research grade Vertical Cavity Surface Emitting Lasers (VCSELs) operate in the short wavelength range making them impractical for applications over 100m or incompatible with a system already operating at the longer wavelengths. Recent research efforts have shown that long wavelength VCSELS are possible but a number of barriers in terms of efficiency, threshold, output, and CMOS compatibility need to be resolved. Specifically, because it is not possible to vary the index of refraction sufficiently in the stacked mirrors, either 100 mirror periods are required to give the needed reflectivity or a new process such as wafer fusion is needed. The former requires extensive deposition time and the latter has not proved effective. Therefore research is required in the area of layer material composition and novel techniques for assembling mirrors and active region as well as getting the reliability to meet the current reliability of the short wavelength VCSELs. This topic seeks new and innovative designs for long wavelength VCSELs that could potentially have 1mW output and is selectively wavelength tuned (during or after wafer processing) for potential compatibility with WDM systems.

PHASE I: Develop and design using commercially available fabrication systems and techniques thermally stabilized VCSELS at 1300nm with a bandwidth of 1GHz. Show potential scale up to 1XN arrays and higher data rates. Show wavelength potential stability with temperature and a high level of integration with driver circuitry.

PHASE II: Produce prototype devices and provide on wafer and device mounted laser characterization. Provide initial temperature and lifetimes characterization. Demonstrate operational device at 1GHz, 1300nm and 100uW output up to 85C without temperature control circuitry. Develop a commercialization plan and discuss barriers to reaching a commercialized product.

PHASE III: Team with a commercial fabrication house or provide in house facilities to demonstrate production runs and document yield and reliability of device. Provide package devices to the government for further testing. Extend power levels to 1mW and demonstrate narrow wavelength devices. Demonstrate a 1XN-array device.

COMMERCIAL POTENTIAL: A low cost long wavelength VCSEL that could replace existing stripe lasers (which require external modulators) targeting the 100m to 1km digital datacom applications would have a great impact on the commercial market. Currently the standards for this area follow the telecommunications standards which are geared towards >2km applications. As a result the sources are expensive and are overkill for the fiber to the home and fiber to the curb markets. However, a low cost ruggedized device that could meet this market would also meet the navy shipboard market. The latter requires devices to operate in connector intensive environments in the 50 to 1000m range with enough power for both single mode and multimode operation and good coupling efficiencies. Additionally, devices which can be made into 1X12 arrays require high yield wafers, and low cross talk designs, but have the added benefit of small footprint and high density packaging for both serial and parallel applications.

KEY WORDS: VCSELs; GaAs; thermally stabilized; fiber optics; arrays; wafers

N99-135 TITLE: Dynamic Resource Allocation inMulti-Level Security (MLS) Environment

SCIENCE/TECHNOLOGY AREA: Command, Control and Communication

OBJECTIVE: Develop and demonstrate Dynamic Resource Allocation of computing resources in a Multi-Level Security network.

DESCRIPTION: Future Navy ships require the dynamic allocation/re-allocation of computing resources for load balancing, failure-mode reconfiguration, and response to threats. The applications operate at different security/sensitivity levels. As applications move from one resource to another, their security/sensitivity levels must move with them. A single dynamically-reconfigurable MLS network is needed because applications cannot be migrated across the physical or logical boundaries between multiple system-high networks.

The R&D technologies that might be exploited in the fulfillment of this SBIR topic include (a) software algorithms that can establish an optimum dynamic reconfiguration of a distributed-computing architecture, (b) high-performance networking that can support the movement of a large number of applications to new host machines, and (c) advanced security mechanisms that can rapidly and dynamically enable/disable the running of applications at different security levels on different host machines.

PHASE I: Develop the architecture of the dynamically-reconfigurable MLS network, identify it's security mechanisms, and develop the methodology by which applications at different security levels can migrate from one computing resource to another resource.

PHASE II: Implement the innovation in the form of a prototype demonstration of the dynamic migration of applications at different security levels. Determine the performance of the innovation in terms of time-to-reconfigure as a function of network protocol/bandwidth, host processor speed and size of application. Explore major cost and reliability issues associated with the technology in the context of commercial viability.

PHASE III: Productize the innovation for use in military and industrial/commercial applications that require non-stop computing at different security and/or sensitivity levels. Military applications include the DD-21 ship class. Industrial applications include power-generating plants, chemical plants and steel mills. Commercial applications include global enterprises that diurnally migrate applications from one time zone to another to exploit excess computing capacity in middle-of-the-night locations.

COMMERCIAL POTENTIAL: Many industrial/commercial activities would use, and benefit from the use of, this innovation. Examples are organizations that require non-stop computing together with privacy of information at multiple security levels, e.g., financial institutions, reservation systems, electronic commerce, lottery systems, factory-floor automation, process-control systems such as steel mills, chemical plants, power generation sites, etc.

KEY WORDS: multilevel-security; MLS; dynamic-resource-allocation; security; encryption; distributed-computing

N99-136 TITLE: Development of Low Cost, Composite, Isogrid Support Structures for Large-Scale Naval Applications of Superconductivity

SCIENCE/TECHNOLOGY AREA: Conventional Weapons, Countermines/Mines

OBJECTIVE: Investigate the design and fabrication of composite isogrid structures to provide adequate support for superconductive magnets in the naval environment while minimizing thermal transfer from ambient to the magnet.

DESCRIPTION: Recent advances in refrigeration technology have eliminated the logistics burden of liquid cryogen associated with large-scale naval applications of superconductive magnets. Using mechanical refrigerators, superconductive magnets as large as 160 cm in diameter have been conductively cooled to below liquid helium temperatures (4.2 Kelvin). A large conductively-cooled superconductive magnet is part of the Advanced Lightweight Influence Sweep System (ALISS) Advanced Technology Demonstration. A key component of the ALISS system is the magnet support structure, which must be rugged to withstand the rigors of operations in the naval environment but also must have the smallest cross-sectional area possible to minimize thermal heat leak to the magnet. The ALISS magnet uses three cylindrical composite support tubes in a re-entrant configuration. However, the cost of the current re-entrant support configuration makes up more than 15% of the ALISS magnetic system cost and involves the most labor intensive step in the fabrication process. There is the potential to transition the ALISS technology to an airborne deployed mine countermeasures configuration. The current re-entrant structure design would complicate system layout.

An initial trade-off analysis indicates that a composite, isogrid structure could provide a reduced cross-sectional area to permit the use of fewer cylindrical composite supports while maintaining the required strength and low thermal heat leak. A simplified support structure could reduce procurement costs, reduce fabrication costs, reduce system weight, and provide additional arrangement flexibility.

PHASE I: Develop candidate composite materials which could be used for advanced composite supports based on strength, heat transfer, and ease of manufacture. Develop both cylindrical and conical isogrid support structures and related design issues. Design issues which should be considered include: optimization of design geometry (number of nodes and winding cross points); incorporation of a land as part of the design to permit winding the superconductive magnet directly onto the outside of the isogrid support; design of the mechanical interface between the end of the isogrid support and the system vacuum vessel; and, design of intermediate thermal intercepts. Identify manufacturing issues, perform preliminary tooling design, and develop a manufacturing approach.

PHASE II: Fabricate several test articles of a length and a diameter appropriate for an airborne deployed mine countermeasures system. More than one of the geometries examined in PHASE I can be produced if the trade-off study performed in PHASE I shows a close comparison. Determine the mechanical properties of the isogrid test articles, including compressive strength, tensile strength, and flexural strength. Determine the thermal conductance of the test article.

PHASE III: Support transition of superconducting magnetic devices to general Naval applications, including propulsion machinery and weapon launcher applications.

COMMERCIAL APPLICATION/ DUAL USE: Potential commercial applications include magnetic resonance imaging (MRI) medical devices, magnetically levitated transportation systems, and advanced physics systems used to conduct experiments requiring high magnetic fields. In addition to mine countermeasures, superconductive magnet systems are being evaluated for naval applications in electric propulsion machinery, energy storage, and advanced launcher applications. Isogrid structures which provide a high strength, low heat leak support system would be an enabling technology for these military applications.

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KEY WORDS: superconductivity; isogrid; composite; cryogenic

N99-137 TITLE: <u>Innovative Techniques To Improved Combat Information Center Processes</u>

SCIENCE/TECHNOLOGY AREA: Manpower and personnel

OBJECTIVE: Reduce manpower requirements for Surface Combatant Combat Information Center operations.

DESCRIPTION: Innovative techniques and methods are required to support the Navy's SmartShip Project's initiative for reducing the manpower requirements for Combat Information Center (CIC) operations. Typically, a modern Destroyer or Cruiser requires 45 crewmembers at Battle Stations to effectively conduct CIC operations, which involve collecting, processing, evaluating, displaying, and disseminating the required data to fight the ship. Planned enhancements to surface ship communication connectivity and networking within the battlegroup as well as ship to shore, will support high order of improvements to traditional CIC processes. Areas of interest include, but not limited to: The intelligent integration of information from various sensors using extended methodologies for designating target location and identification; Visualization technologies that leverage the advances in connectivity/networking and focus on increasing the effectiveness of CIC operations ; leading edge technologies in the areas of optics and digital video processing; innovative approaches in enhancing visualization of realistic images of objects/targets within the simulated battlespace.

PHASE I: Develop new concepts and describe or model both the current Surface Combatant CIC processes and the improvements resulting from application of the new concepts. Include data transport delays (senessence) and other effects associated with each process step, (eg: operators), in the description of the current an improved processes. Identify the procedures, methods and new equipment required for the process implementation, and develop an implementation strategy.

PHASE II: Demonstrate the new concepts, including the expected/predicted improvement(s), from Phase I at Navy's SmartShip Project ACIC of the Future landbased prototype. Inlcude any applicable and/or prototype equipment form Phase I in the demonstration.

PHASE III: Demonstrate the new concepts and/or prototype equipment on a selected ship.

COMMERCIAL POTENTIAL: All Operations Centers and Control Stations for transportation industries could utilize improved processes.

REFERENCES: Configuration Definition Document for AEGIS Guided Missile Destroyer # N010-003.

KEY WORDS: Information, Manpower, Visualization

N99-138 TITLE: Microwave High Power Limiter

SCIENCE/TECHNOLOGY AREA: communications

OBJECTIVE: Develop a C-band high power (250 watts minimum) limiter for military communication systems.

DESCRIPTION: As the trend toward smaller and higher power microwave communication systems continues, the requirements of the individual components become more demanding. Solid state and vacuum devices continue to become more powerful. Protection against these higher power levels must be provided for expensive, power sensitive circuits. As an example, the Cooperative Engagement Capability (CEC) Airborne Transceiver system currently uses solid state FETs to generate power levels up to 100 watts. This power level approaches the limit of current limiter technology. As the system power level is increased (via Microwave Power Modules or higher power FETs), the power capability of the limiter must correspondingly increase to protect against component failure. For airborne and joint service applications, CEC has the need to increase RF power to meet current operational requirements.

PHASE I: Design a high power C-band limiter that can handle power levels of 250 watts or greater. Design(s) should be for a ground base environment and an airborne environment. Size/weight of the design should be minimized. The detailed specifications will be generated. The design shall include detailed electrical and a mechanical analysis.

PHASE II: Create fabrication drawings and build a prototype limiter. Tests shall be conducted to verify power handling capability, insertion loss, VSWR, flat leakage, and recovery time. Temperature and altitude testing shall also be conducted to assess the performance of the limiter in a military environment. Prepare a report that includes all design parameters and test results.

PHASE III: Fabricate one set of limiters for insertion into a CEC transceiver system with high power devices for demonstration testing.

KEYWORDS: high power microwave limiter, Microwave Power Modules, electronics device

N99-139 TITLE: Non-Metallic Netting for Deck Edge Safety Nets

SCIENCE/TECHNOLOGY AREA: Materials

OBJECTIVE: Select an alternative non-metallic netting material with a lower life cycle cost as a replacement for nylon netting on ships where Electromagnetic Interference (EMI) and weight are a concern.

DESCRIPTION: Non-metallic netting is required in areas not subject to high heat in order to reduce topside EMI effects, and to save weight on weight and/or stability critical ships. Historically, nylon netting has been used to meet this need; however, nylon netting degrades in sunlight and requires replacement on an annual basis. This effort would investigate alternative lightweight non-metallic materials that can withstand sunlight, abrasion, and not deteriorate in a seawater environment in order to extend the replacement periodicity and to reduce the life cycle costs of non-metallic netting for deck edge safety nets.

PHASE I: Perform material studies to identify non-metallic materials suitable for fabricating netting for deck edge safety nets. Evaluate each material for strength; weight; ease of fabrication; resistance to sunlight, saltwater, temperature, fire, abrasion; availability; suitability for this purpose; and life cycle cost. Develop an environmental and strength test procedure, perform environmental and strength testing of the most highly rated candidate materials, and evaluate and report the findings. The specific materials properties goals are: minimum breaking strength of 3500 pounds; 125% weight of nylon (maximum); producible using existing technology and equipment at a cost not to exceed 150% of current production cost for nylon netting; resistant to direct sunlight and saltwater for 5 years (minimum); no loss in strength up to 175 degrees F and down to B40 degrees F; fire resistance greater than or equal to nylon; resistant to wind-load abrasion for 5 years minimum.

PHASE II: Develop prototype designs for fabrication of nets and an evaluation plan to test and evaluate the top candidate materials in a shipboard environment. Fabricate and install candidate netting on the selected test platform. Conduct periodic inspections, and analyze and report findings to determine the expected life of candidate materials.

PHASE III: Prepare a field test report, analyze results, and select a replacement material. Develop or revise fabrication procedures, installation procedures, and in-service testing procedures for replacement material. Revise appropriate standards, drawings, and logistical data to reflect replacement material usage.

COMMERCIAL POTENTIAL: The selected replacement material could be used in cargo nets and other commercial applications where ultraviolet stability and strength are required.

KEY WORDS: Non-metallic, nets, nylon, EMI, weight, cost

N99-140 TITLE: Virtual Distributed Real-Time Operating System for Real-Time Combat Systems and Joint Systems Like CEC

SCIENCE/TECHNOLOGY AREA: Computer Sciences; Computers, Software

OBJECTIVE: To develop a virtual real-time framework for integrated platform combat systems and joint warfare coordination systems which will present a long term solution framework to guide in designing wrapper ware and middle ware, which meets the real-time processing requirements, and which supports fault tolerance, redundancy, reconfiguration, and graceful degradation requirements of advanced distributed systems.

DESCRIPTION: Commercial distributed real-time operating systems have requirements which are very similar to the requirements for middle ware to support an integrated platform real-time combat system or coordination system. Middle ware provides the glue which holds together the distributed processing assets and processes of a combat system or coordination system. Middle ware for these systems can be viewed abstractly as a Virtual Real-Time Operating System. Combat and coordination system middle ware can be designed as a Virtual Real-Time Operating System providing real-time, multi-thread operating system capabilities by using current commercial operating system technology and principles. The Virtual Real-Time Operating System for combat or coordination systems must address fault tolerance, redundancy, reconfiguration, and graceful degradation issues like fault latencies, failure modes, and battle damage concerns. Research into application of the same concepts and principles used in distributed real-time, multi-thread operating systems to defense related systems could provide major improvements in combat and coordination system design which is the objective of this research project.

PHASE I: Research and design a Combat System or Coordination System Middle ware Virtual Real-Time Operating System. Examine commercial operating system technology and hardware architecture to find parallel requirements. Document results in a Phase 1 report.

PHASE II: Develop a design process which incorporates the techniques, architectures, and approaches from Phase 1 in design of an integrated combat or coordination system for different architectures options that are considered feasible for combat systems or coordination systems. Document the processes, techniques, and alternative architectures in a Phase 2 report.

PHASE III: Incorporate the techniques, processes, and architectures into the design of commercial systems with the same fault tolerance, redundancy, reconfiguration, graceful degradation, and real-time requirements needed for military combat and joint force coordination systems but also extends the processes, techniques, and architecture alternatives to fit into the COTS hardware and software design framework. Phase 3 includes development of tools to support the process with COTS hardware and software.

COMMERCIAL POTENTIAL: Real-time control systems with fault tolerance, redundancy, reconfiguration, and graceful degradation requirements need a process and tool sets to provide the same high level of quality and reliability required by defense systems but the commercial sector does not have the same research resources that DOD has to design the process and tool set.

KEY WORDS: Real-Time; Distributed Processing; Command and Control; Combat System; Coordination System; Operating System

N99-141 TITLE: Automation & Software Development for Material Handling/Categorizing Systems

SCIENCE/TECHNOLOGY AREA: Computers, Software

OBJECTIVE: Automate categorization, nesting, and handling of steel plate used in fabricating structural shapes (i.e. I-beams, T-beams).

DESCRIPTION: This effort would expand existing software capabilities to support dynamic nesting of parts and remnants and the optimum relationship between individual parts to support fabrication into a final component. Software to plan and automate the usage and handling for steel plating and other materials has been demonstrated as a useful tool to optimize scheduling and procurement of materials in a manufacturing environment, but is limited in capabilities required for structural components and manufacturing applications.

PHASE I: Develop user-friendly software modules and tools to dynamically categorize, sort, and arrange lightweight materials used to fabricate structural components. Utilizing a manufacturing schedule, this software should be able to distinguish between different parts, develop a relationship between parts needed for a particular shape, nest parts without log jamming the system, and dynamically handle remnant parts.

PHASE II: Integrate the Phase I software into commercially available handling systems and test & Demonstrate and evaluate its ability to sort and handle light weight steel plate used in fabricating structural shapes.

PHASE III: Package user friendly software to allow the shipbuilder or other manufacturing facility to input scheduling requirements for fabrication of parts.

COMMERCIAL POTENTIAL: This software could be applicable to any manufacturing facility which fabricates structural components from lightweight steel plates.

KEY WORDS: Automation, software, nesting, handling, plating, structural

N99-142 TITLE: Virtual Prototype Methodology for Radar Digital Signal Processor Development

SCIENCE/TECHNOLOGY AREA: Modeling and simulation

OBJECTIVE: Develop a methodology based upon the ARapid Prototyping of Application Specific Signal Processors (RASSP) Program for applying simulation based, virtual prototyping technologies throughout the life cycle of modern radar digital signal processors.

DESCRIPTION: Modern radars perform multiple functions. The design and development of the signal processors for these radars poses several significant technical challenges. First, the signal processors have to process large volumes of data in response to a rapidly changing stream of waveforms or modes. Secondly, the processing performed in each mode is to be accomplished with low latency times. Lastly, the signal processors are expected to be readily adapted to perform new processing or new missions and to readily accommodate component evolution or obsolesce. To meet processing and adaptability demands, massively parallel processor architectures (MPP), based on using large numbers (100s) of programmable processors, are being considered. A recognized problem faced with using this approach to a computing architecture is the lack of a methodology (process, software tools, etc) for evaluating of alternative processing architecture decisions throughout the life cycle. One approach identified for addressing this problem is the use of simulation based technologies. However, there are several shortcomings in current day simulation based technology which impede its use. There is a need for innovative efforts to determine and demonstrate the use of simulation based technology throughout the life cycle of modern radar digital signal processors.

PHASE I: Define a methodology for applying simulation based approaches to the development and continued evolution of signal processing architectures for modern radars. Develop and document requirements and identify candidate software tools that could be used to support the methodology. The virtual prototype methodology should build upon the RASSP technology developed by DARPA.

PHASE II: Implement a portion of the simulation based methodology using currently available software tool(s) and demonstrate its use in the design of a modern radar signal processor (demonstration tool(s) to be agreed upon jointly by the Contractor and the Governemnt).

PHASE III: Develop a fully functional simulation based methodology for use with modern radars.

COMMERCIAL POTENTIAL: Demands of radar signal processing, combined with long life span requirements are greater than those currently found in commercial applications. Enhancements to software tools and methodology are likely to guide capabilities provided in commercially available tools. Further, the use of parallel processing architectures in commercial applications (e.g., medical visualization or rendering, data mining) as well as civilian radar applications (e.g., air traffic control) has been slow due to the lack of suitable tools and methodologies. Innovations resulting from this effort will facilitate broader commercial use of parallel processing technology.

REFERENCES:
1) Simulation of Communication Systems, Jeruchin, Balaban, Shamugan, 1992, Plenum Press, NY.
2) AVIUF Fall 1997 Conference, Rapid Systems Prototyping with VHDL, October 19 - 22, 1997, Arlington, VA.

KEY WORDS: Radar; parallel processor; virtual prototyping; life cycle; RASSP; DSP

N99-143 TITLE: Aluminum Nitride Infrared Window

SCIENCE / TECHNOLOGY AREA: Materials

OBJECTIVE: Develop a method to produce aluminum nitride seeker windows that are transparent in the 3- to 5-micron wavelength infrared region.

DESCRIPTION: Sapphire is the current material of choice for mid-wave infrared seeker windows on high speed missiles because it has the greatest thermal shock resistance of any available window material. Materials with twice as much thermal shock resistance are required for hypersonic missiles that are currently being planned. Aluminum nitride can potentially meet this requirement. Aluminum nitride has a strong birefringence, which has so far prevented the fabrication of transparent polycrystalline materials. Birefringence causes significant optical scatter which cannot be tolerated in a seeker window. The goal of this program is to fabricate single crystal or polycrystalline (nanocrystalline) aluminum nitride with a thickness of 2 millimeters, less than 2 percent scatter at a wavelength of 4 microns, an absorption coefficient less than 0.1 per centimeter at a wavelength of 4 microns, and a thermal conductivity above 160 watts per meter-kelvin at room temperature.

PHASE I: Demonstrate the feasibility of fabricating aluminum nitride with at least 65% transmittance at a wavelength of 4 microns when the thickness is at least 1 millimeter.

PHASE II: Refine the process to prepare aluminum nitride disks with dimensions of at least 2 millimeters thickness and 25 millimeters diameter with the following properties: < 2% scatter at 4 microns; absorption coefficient < 0.1 per centimeter at 4 microns; and thermal conductivity > 160 watts per meter-kelvin 20EC. Material meeting the optical requirements will have a transmittance of 74% at 4 microns. Measure the mechanical strength of optical quality disks (25 mm diameter x 1.5 mm thick) using ring-on-ring flexure. Strengths should be measured on 20 disks at 20EC and 20 disks at 600EC. Target strengths are >200 megapascals at both temperatures.

PHASE III: Transition fabrication technology into a production facility capable of manufacturing 90-millimeter-diameter hemispheric domes (thickness ‘ 2.5 mm) or flat rectangular windows with dimensions up to 100 mm x 200 mm (thickness ‘ 5 mm) for use in a selected hypersonic missile system. Establish a database of physical properties including thermal conductivity, mechanical strength, modulus, expansion coefficient, and optical absorption coefficient as a function of temperature up to 1000EC. Develop an antireflection coating that provides >90% transmittance in the wavelength range 3-5 microns for 2.5 mm thick parts coated on both sides. Measure the change in transmittance of bare aluminum nitride and antireflection-coated aluminum nitride in rain and sand erosion experiments.

COMMERCIAL POTENTIAL: Aluminum nitride will be available for military and civilian applications such as windows for optical monitors in high temperature manufacturing processes, optical sensors in turbine engines, and optical sensors in power plants. High quality aluminum nitride has potential as an electrically insulating, heat spreading component in high power electronic components including high density integrated circuits and microwave components.

REFERENCES: D. C. Harris, "Infrared Window and Dome Materials," (ISBN 0-8194-0998-7) SPIE Press, Volume TT10, 1992

KEY WORDS: ceramics, aluminum nitride, thermal shock, infrared window, infrared dome; infrared seeker

N99-144 TITLE: Novel Gun Pointing Scheme

OBJECTIVE: Develop a gun pointing scheme best suited for launching guided projectiles in a long range fire support role. The pointing scheme should allow the gun to be installed and operated below deck, installed in a module, and should minimize the weight and volume impact on the ship. Additionally, the concept should allow active and passive techniques for reduction of thermal, radar, and muzzle-blast signatures.

DESCRIPTION: The Naval Surface Fire Support (NSFS) program wishes to explore the design space of very long, efficient gun barrels made of modern engineered materials. Current guns, which must train, elevate, and recoil, have a major impact on the ship and on the other systems onboard. Attempting to install a long, powerful gun of classic design would produce a ship that was dominated by this single weapon. This topic seeks approaches to take advantage modern materials and designs to produce a long gun barrel that can be integrated more readily into the ship. The key feature of this gun is a vertical mounting, with a bendable barrel to provide train and elevation over a limited arc. To achieve this property, the barrel must be composed of anisotropic materials such as metal-matrix composites, which provide high hoop strength while permitting some degree of axial bending. Augmenting this structure, the inside of the barrel must be an advanced liner and coating system to support propellant temperatures up to 2900 K. Outside of the barrel’s pressure vessel is an external truss that provides the bending forces to steer the barrel as well as a signature-management system to provide cooling, radar and thermal signature hiding, and a muzzle brake/exhaust blast management and cooling system. The intention of this SBIR topic is to explore the feasibility of this design, and the suitability of materials to support it, in a subscale model that can, if successful, be implemented in a 5-inch barrel 160B200 calibers long.

PHASE I: Complete a prototype structural design of the metal-matrix barrel in a subscale size. Dynamically model the structural response of the barrel during firing, optimized the design of the external stiffening/train-and-elevation device, and evaluate the effects of the design on projectile tip off and in-bore balloting forces.

PHASE II: Fabricate a subscale barrel for single-shot firing, validate the structural design and response predictions, and incorporate signature reduction features into the design.

PHASE III: Fabricate a 5-inch gun based on the Phase I designs. Integrate signature reduction treatments and muzzle blast reducer into a demonstrator/prototype.

COMMERCIAL POTENTIAL: New metal refractory materials and anisotropic metal structure designs have great potential in the commercial automobile and aircraft industries. The maximum operating temperature of the hot parts of almost any engine in use today is the primary limitation of their thermodynamic efficiency. A new sintered oxide refractory alloy being developed for gun applications possesses all the desirable properties for today's high-efficiency engines. Similarly, metal-matrix materials provide an important bridge between isotropic metals and composite/epoxy for high strength/high temperature applications. More importantly, metal-matrix materials combine the advantages of these materials without most of the disadvantages. The signature reduction aspects of this topic also have direct commercial application. Infrared cross-section treatments also have application to thermal insulation, particularly for industrial equipment such as steam power plants, chemical plants, and heavy equipment engines. Radar cross-section reduction treatments can be used to reduce electromagnetic interference, particularly co-site problems. These problems are increasing as localities restrict the erection of new cellular telephone base station towers. Other changes that exacerbate EMI problems are the new 940 MHz Personal Communications System licenses, wireless computer LANs, and crowding of satellite earth stations by point-to-point microwave. Of note, the April 1997 issue of Microwave Journal includes ads from four manufacturers of RF absorbing material and solutions to co-site interference problems.

KEY WORDS: gun barrel; metal matrix; radar; cross section; infrared; absorption

N99-145 TITLE: Multi-Sensor Correlation Displays

SCIENCE/TECHNOLOGY AREA: Sensors, Software Computing

OBJECTIVE: Develop new display formats that facilitate multi-disciplinary and multi-sensor presentation of data on reduced manpower 21st century surface combatants. Develop an effective means to efficiently manage, visualize, and evaluate the typically high volume of rangeless information such as Electronic Warfare against localized Combat System data.

DESCRIPTION: Proposed manpower limitations on the new surface combatants will require the use of innovative combat system display techniques. Operators from multiple disciplines will be required to use a common set of displays that will present multi-sensor data. A common display concept is vital to the multi-disciplinary aspect of this system. Current Combat System display methods of simultaneously presenting ranged and rangeless data have proved unsuitable for integration of such domains as Radar, Electronic Warfare and Sonar where there is a high incidence of non-correlated rangeless sensor data. Improvements to the traditional methods of integrating the visual representation of multi-sensor data for both ranged and rangeless data while preserving geo-spatial and tactical situation awareness can greatly improve the fleet's effectiveness while reducing the operator's workload. Interfaces to the various sensor systems are necessary to include their data on a common set of displays. The displays should give the operator access to data, not only contacts, without requiring the operator to drill down into unfamiliar display systems; The displays should be capable of presenting data and contacts in an effective and efficient manner. Consideration should be given to the ability to overlay multiple data types (at the contact or data level) effectively and the presentation of logical guides to orient the operator to the scenario quickly. Development of automation type tools to help operators manage and follow multiple data types on the display is vital.

PHASE I: Develop innovative display storyboards which demonstrate candidate data rendering techniques within specified Combat System Guidelines sufficient to solicit and incorporate fleet feedback and refinement.

PHASE II: Design and fabricate a proof of concept prototype display which incorporates the techniques developed during Phase I of this effort.

PHASE III: Full development and production for application to Electronic Warfare and other Systems.

COMMERCIAL POTENTIAL: Display techniques developed can be transferred to a variety of commercial and military applications to include airborne and sonar sensor systems, air traffic control, and drug interdiction.

KEY WORDS: Data Fusion, Electronic Warfare, Displays, and Advanced HMI

N99-146 TITLE: Body-to-Body Penetration and Damage Models

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop a fast-running, analytical/engineering methodology and computer code to predict terminal ballistic interactions between complex structures.

DESCRIPTION: The Navy is striving to develop more effective anti-air missile systems to defeat tactical ballistic missiles (TBMs) as well as cruise missiles and aircraft. Damage from direct hits by interceptor launched projectiles is the primary mechanism for defeating TBMs for some concepts. Analytical methodologies are required to evaluate new concepts, optimize weapon designs, and evaluate system effectiveness. Current lethality assessment methodologies either calculate the projectile projected area that is swept through the target, or use a hydrodynamic crater algorithm which requires homogenized target and projectile density and strength properties, as well as numerous other assumptions. As such, single penetrator methodologies do not account for the effect of target responses (e.g., target element acceleration and material removal) from earlier impacts on the encounter conditions and target response for later impacts. The temporal resolution of terminal ballistic target loading and response is needed for accurate weapons effects assessments associated with both single and multiple homogeneous penetrator impacts, as well as impacts between complex, spatially extended structures. The utility of hydrocodes to optimize designs and evaluate effectiveness is limited because of run-time, costs, required expertise, and the inability to use them in higher level simulations. New concepts in modeling are needed to predict body-to-body penetration and target damage in a fast-running, yet sufficiently accurate way.

PHASE I: Identify the geometric, kinematic, and dynamic loading and response problems associated with ballistic impacts between complex structures over a range of intercept velocities. Describe the main features of the objective prediction methodology, including interceptor and target geometry, physics- based terminal ballistic loading and response models, and their time resolution. Develop an understanding and sensitivity of the more important parameters involved. Provide a limited demonstration of the key concepts.

PHASE II: Develop the objective prediction methodology and a fast running computer code for use in lethality assessment and system effectiveness studies. Demonstrate its application for a selected complex projectile/target combination of current interest. Plan experiments to validate the models. Validate the computer code by comparison with experimental data and selected numerical simulations.

PHASE III: Improve and extend the model and implement it into lethality assessment and system effectiveness simulations used by the weapon development community.

COMMERCIAL POTENTIAL: Utilization of the methodology in government and commercial vulnerability/lethality and risk assessment computer codes and as an aid to weapons design and protective structure design. Potential applications include vehicle crashworthiness analyses, accident investigation, design of containment structures for industrial accident debris, design of hazardous materials shipping containers, anti-terrorist barriers, and vehicle armor.

KEY WORDS: direct hit; body-to-body; projectile; penetration; lethality; vehicle damage

N99-147 TITLE: Mission Planning for Tactical Shipboard EW Systems

SCIENCE/TECHNOLOGY AREA: Software, Electronic Warfare Technology

OBJECTIVE: Develop a methodology for the utilization of a wide variety platform, sensor and weapons intelligence databases, emitter intercept logs and mission objectives to adapt tactical shipboard EW sensor resources and responses.

DESCRIPTION: Existing tactical EW systems currently utilize databases generated by land based intelligence centers that can not be adapted to dynamically changing conditions. Emitter/Platform associations, platform location and emitter parameters may change faster than intelligence centers can cycle updates to the affected tactical shipboard EW system. Tactical shipboard EW users need the ability to analyze the various intelligence databases, visualize anticipated sensor and weapons coverageís, and visualize emitter intercept logs from organic and non-organic sensors. Utilizing this information, the tactical shipboard EW user should be able to generate system resource management doctrine, which adapt tactical shipboard EW sensor resources and responses for the mission.

PHASE I: Identify existing databases that can support the specific tactical shipboard EW system. Identify methods to allow the tactical shipboard EW system user to visualize the anticipated environment. Identify tools that allow the tactical shipboard EW user to adapt reference databases to the anticipated environment. Identify tools to develop and test resource management doctrine. Define innovative hardware and software elements, development and operational software environments and identify a real-time application with which to demonstrate the architecture.

PHASE II: Demonstrate a new integrated architecture composed of a state-of-the-art processor configuration which makes maximum use of off-the-shelf components, open system architecture, relies on commercial industry standard communication media and physical connections, and drastically reduces the number of unique components. This effort should show that the existing defense computing system components could be upgraded and/or changed without extensive application code development.

PHASE III: Full development and production for application to Electronic Warfare Systems.

COMMERCIAL POTENTIAL: Commercial applications for situation awareness visualization techniques, integrated database analysis tools and tools that allow the user to develop rules to optimize system resource include: FAA Air traffic control ñ Sensor Mapping, Weather Mapping, AIR Traffic Routing with re-routing rules; Cellular telephone and Pager Systems ñ Tower Site Coverage Mapping with Interference and outage re-routing rules; Commercial Satellite ñ Coverage, Interference control with bandwidth utilization rules; Internet ñ Site mapping, Message routing and re-routing rules. In each of the above applications, geographic mapping displays integrated with a database with interactive database query mechanisms with innovative data visualization techniques allow the commercial user to plan for and respond to very dynamic situations.

KEY WORDS: Database visualization, rule based resource management, COTS, real time computing systems, and signal processing.

N99-148 TITLE: Improved Time and Frequency Standards for Gun-Launched Projectiles

OBJECTIVE: Develop rugged time and frequency standards to support GPS navigation of gun-launched projectiles

DESCRIPTION: Current guided projectiles are constrained by performance limitations on their frequency references. Current crystal frequency references are acceptable but increased accuracy will require new frequency reference. The frequency reference provides both a frequency reference for the receiver and a time reference for the spread-spectrum code. Before launch, the frequency and time references are synchronized and biases are estimated and compensated for. These events happen as part of fuze setting, along with entry of aimpoint, ship's position, and GPS satellite ephemeris data. The frequency reference must maintain these references during this time, through the shock of gun launch, until the receiver acquires. It must be able to maintain its performance despite temperature variations ranging from B40EC storage for Marine Corps and Army ammunition in the field, to 200EC after loading into a hot gun. For shipboard use, the delay between synchronization and firing is typically short, (tens of seconds) but may be extended by interruptions in the firing process, test/exercise constraints, or misfire of the gun. For field use, the delay is typically longer, up to two minutes. This topic will ask for a significant performance improvement and cost reduction over the current quartz crystals, for which the following characteristics are given. Performance is particularly desired in shock survival, with an objective of 30,000 g. Improvements in stability (that is, frequency sensitivity to shock and thermal changes) is also desired.

Current reference frequency

Shock environment: Setback: 16,000 g (g = 9.8 m/sec2) 3 ms rise time, 10 ms duration. Lateral Balloting: 3,200 g. Setforward: 4,000 g, 0.3 ms rise time. Launch Vibration (RMS): 6 g, 20 to 2000 Hz. Maximum Roll Acceleration: 50,000 Hz/s. Maximum Roll Rate: 250 Hz.

Shock induced frequency shift: "1.5 parts per million

Thermally-induced frequency shift: "1.5 parts per million over the range 10ECB70EC

Output frequencies: 10,949,297 Hz and 21,898,594 Hz

Output Signal: CMOS Digital, driving 2 standard CMOS loads

Power Input: 5 V "5%, voltage noise 10 mV p-p 10 kHz to 2 MHz

Power Consumption: 220 mW

Aging: "2 parts per million per year

SSB Phase Noise at 43,797,188 Hz: 10 Hz, -80 dBc; 100 Hz, -100 dBc; 1 kHz, -130 dBc, 10 kHz, 0135 dBc.

PHASE I: Develop a design for the time and frequency reference, and demonstrate any key process or component steps.

PHASE II: Fabricate prototypes and demonstrate their performance under high-g launches in an air gun or rail gun. The demonstration should include enough samples to provide confidence that the reference will consistently survive and maintain their performance.

PHASE III: Incorporate the reference into Navy, Army, and Marine Corps guided projectiles such as the EX-171 Extended Range Guided Munition, XM-982, and Competent Munition ATD guidance unit.

COMMERCIAL POTENTIAL: This product is directly applicable to commercial GPS applications, particularly high-shock or vibration environments such as vehicle and cargo tracking, instrumentation for destructive testing, and construction, as well as time and frequency standards for data communications in those same environments.

REFERENCES:
1. System Specification for the CMATD GN&C Enhanced Artillery Round, C. S. Draper Laboratory, Inc. 11 June 1997
2. Subsystem Specification for the CMATD G-Hardened Precision Oscillator and TCXO Electronics, C. S. Draper Laboratory, Inc. 11 June 1997

KEY WORDS: clock; oscillator; resonator; quartz; time; frequency; GPS

N99-149 TITLE: Alternative Manufacturing Techniques for Thermal Batteries

SCIENCE/TECHNOLOGY AREA: Aerospace propulsion and Power

OBJECTIVE: Improve energy density of thermal batteries used in missile applications.

DESCRIPTION: Present manufacturing techniques for manufacturing thermal batteries utilize pressed powders for the anode, cathode, electrolyte and heat pellets. Alternative methods for manufacturing such as tape casting, vapor deposition or laser ablation may offer improved energy density if applied to the manufacture of thermal batteries.

PHASE I: Investigate alternative methods for manufacture of thermal battery cells for use in missile applications. Deliverables might include: identification of challenges, evaluation of issues of size, weight, form-factor, thermal management, safety, mechanical and chemical stability, high voltage use (>160V) and pulse power capability (>300A); demonstration of selected technology.

PHASE II: Deliver prototype batteries manufactured using method(s) selected in Phase I for evaluation against existing technology.

PHASE III: Development of a battery capable of fully satisfying mission requirements for an existing missile system.

COMMERCIAL POTENTIAL: This technology would have application in areas concerned with emergency electrical power, as well as the metallurgical industry.

REFERENCES: Linden, David, "Handbook of Batteries and Fuel Cells", 2ed.

KEY WORDS: electrochemical; battery; thermal; power; anode; cathode

N99-150 TITLE: Enhanced Platform Tracking Based on Multiple Emitter Reports Detected by a Single Sensor System

SCIENCE/TECHNOLOGY AREA: Sensor

OBJECTIVE: Develop a methodology for effectively applying existing emitter contact tracking and correlation techniques to group and platform tracking requirements.

DESCRIPTION: Existing tactical EW systems currently perform emitter contact tracking. Multi-emitter correlation is performed on these systems to enhance identification. However, when emitters are no longer detected by the system, knowledge of emitter relationships to the source platform is removed. When the emitter signal is re-acquired by the sensor, the system must perform re-correlation. Each time re-correlation is performed, the system typical carry forward no prior knowledge of past associations and any knowledge imparted by operators or other correlation functions is lost. By implementing a long term tracking algorithm coupled to a multi-emitter platform correlation algorithm the need to continuously perform re-correlation can be reduced, emitter identification can be enhanced and improved situation awareness of the platform operations can be achieved.

This effort will assess the viability of combining existing emitter contact tracking algorithms and existing correlation algorithms into a tightly coupled algorithm.

PHASE I: Develop emitter contact tracking and emitter correlation algorithms that exhibit performance characteristics needed to support multi-emitter platform tracking.
This effort will define innovative hardware and software elements, development and operational software environments and identify a real-time application with which to demonstrate the architecture.

PHASE II: Demonstrate a new integrated architecture composed of a state-of-the-art processor configuration which makes maximum use of off-the-shelf components, open system architecture, relies on commercial industry standard communication media and physical connections, and drastically reduces the number of unique components. This effort should show that the existing defense computing system components could be upgraded and/or changed without extensive application code development.

PHASE III: Full development and production for application to Electronic Warfare Systems.

COMMERCIAL POTENTIAL: Any commercial computing system could benefit from multi-report tracking and correlation technology. Potential markets include commercial manufacturing industry and air traffic control.

KEY WORDS: Emitter tracking, group tracking, platform tracking multi-emitter correlation, COTS, real time computing systems, and signal processing.

N99-151 TITLE: <u>Optimization of the Ultra Broadband Radiation Source</u>

SCIENCE/TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: Enhance the attractiveness of the ultra broadband, high average power radiation source for IR countermeasure applications by providing modifications that reduce its weight, size and cost.

DESCRIPTION: Recently, a new approach has been proposed for generating high average power ultra broadband radiation by beating two CO2 laser beams with slightly different frequencies in a nonlinear medium. More recent studies have shown that such a source can produce high average power radiation in every IR atmospheric window of interest and therefore, it has the potential to provide efficacious countermeasures for high value, high signature platforms, which presently have only limited protection. Although the source has several attractive features, further improvements on its weight, size and cost would be desirable. Specifically, the replacement of the two CO2 lasers with a single laser would substantially reduce the weight, size and cost of the system.

PHASE I: Develop one or more concepts that are capable of providing two lines with closely spaced frequencies using a single CO2 driver. Assess relevant proof-of-principle experimental data. In addition, provide reliable weight, size and cost estimates and determine the efficiency of the system and the directional properties of the radiation.

PHASE II: Design, fabricate and test a radiation source that is based on the conceptual design of Phase I. Assess its suitability for countermeasure applications.

PHASE III: In partnership with industry develop a high average power prototype jammer having the desired repetition rate capability.

COMMERCIAL POTENTIAL: Ultra broadband, high average power radiation sources have a host of civilian potential applications, including active remote sensing of atmospheric pollutants and wireless communication. In addition, they may benefit from the various law enforcement agencies, since they may power DIAL sensors that have the potential to remotely detect the atmospheric molecular constituents of narcotics during processing activities as well as of explosives stored in large containers.

REFERENCE: Sprangle, P., et al., Naval Research Laboratory Memorandum Report NRL/MR/6790-96-7805.

KEY WORDS: Countermeasures; Lasers; Nonlinear Optics; Ultrabroadband Source; High Power; IR

N99-152 TITLE: Power Beaming of Millimeter-Waves for UAVs

SCIENCE/TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: Develop a capability to power UAVs by beaming millimeter-wave power from a transmitter to the UAV, and converting the received energy into electrical power by means of a rectenna (a half-wave dipole array with integrated diode rectifiers). This should permit prolonged mission duration compared to other means of powering UAVs, including onboard batteries. For near-ship applications, this would avoid the requirement of using tethers to provide the power. By proper choice of operating frequency, in order to operate either near an atmospheric window or an atmospheric absorption line, a suitable trade-off should be achieved between mission range and operational covertness.

DESCRIPTION: Small Unmanned Airborne Vehicles (UAVs) are of considerable interest for a variety of tactical military missions. Ship-based UAVs are being developed by the Navy as decoys and sensor platforms which should maintain a position within a few 100 m of the ship. Current prototypes make use of tethers to provide the power, which limits their performance. Also, very small airborne vehicles micro-AVs with a wingspan of a few inches are being considered are being considered for missions such as covert surveillance, jamming of targeting radars, and target designation. Battery-powered micro-AVs would be limited to mission duration of a few minutes. For both UAVs and micro-AVs, millimeter-wave power beaming could provide the power for indefinite-duration missions, with powers ranging from tens of watts for micro-AVs to a few kilowatts for UAVs. The use of millimeter-waves, rather than longer wavelength microwaves, can provide the necessary range capability with acceptable antenna sizes. Commercial high-average-power gyrotrons can provide the millimeter-wave power at the transmitter. Rectennas on the UAV or micro-AV can in principle convert the millimeter-wave radiation into electrical power with an efficiency of ~50%. The key limiting factor in developing prototype power beaming systems is the present state of the art of rectenna development. The Navy is interested in further prototype rectenna development in support of future power-beaming systems

PHASE I: Develop and test a 35 GHz prototype rectenna to produce 20 W of DC power. Carry out a design study addressing issues of power, range, efficiency, optimum frequency, and potential covertness of power beaming to UAVs and micro-AVs.

PHASE II: Develop and test rectennas at either 60 or 94 GHz, depending on evaluation of issues of range versus covertness. Develop a rectenna to produce at least 20 W of DC power with 50% conversion efficiency. Integrate rectenna in 16 inch wing-span of micro-AV prototype.

PHASE III: In partnership with industry, develop a complete micro-AV power beaming system, that includes a source of 60 or 94 GHz radiation, a transmitter-tracker, and a micro-AV powered by millimeter-wave radiation. Develop methods for low-cost manufacturing of rectenna systems.

COMMERCIAL POTENTIAL: Micro-AVs with long-duration flight capability powered by millimeter-wave power beaming may have application to civilian law enforcement, drug control, or border patrol agencies for covert surveillance applications.

REFERENCES: T.-W. Yoo and K. Chang, Theoretical and Experimental Development of 10 and 35 GHz Rectennas, IEEE Trans. Microwave Theory Tech., vol. 40, p. 1259-1266, June 1992; Palmtop Planes, New Scientist, 5 April 1997, pp. 36-41.

KEY WORDS: millimeter-wave radiation, power beaming, UAV, micro-AV

N99-153 TITLE: Sneak Circuit Analysis for Software

SCIENCE/TECHNOLOGY AREA: Computer Sciences, Computers, Software

OBJECTIVE: To eliminate unintended operational errors, states, or modes of corruption by finding problems related to current design processes that do not follow a top down hierarchical flow down process.   And to use design models that are limited to the major aspects of the system design without concern for unintended paths or cross-linkages either introduced by process and environmental requirements or by implementation details from components whose capabilities are not required by the current design model(s).

DESCRIPTION: In hardware design during the design process, performance and other design requirements drive the design development in a top down fashion. If the design processes were simply a tree structure, though, this type of process would simply involve deductive methods and traceability would allow a logical evaluation of consistency. The design process, however, involves other cross pollination types of requirements which lead to alternate paths or relationships. In addition in hardware, there are real world and real object characteristics that are carried along which are not included in the detailed hardware models used for design. Because of the cross pollination of requirements and the fact that real object detailed interactions are not evaluated because the design process focuses on good object, model, and performance issues, undesired interactions are possible which can cause unwanted performance impacts, especially in the failure area, that designers are not aware of because of the limitations of the design models and because the flow down process focuses only on good system performance. Sneak circuit analysis was designed to look at some of the undesirable or safety related unwanted side effects from such a design process. Software has similar cross pollination and limited models focus in the design process, especially in the reuse of software, which can cause similar undesirable and destructive paths leading to unknown modes and states relationships that need further analysis like a sneak circuit analysis for software. This research project is to define the types of design process and model limitations that lead to sneak paths in systems and software and to develop design processes, techniques, and tools to evaluate the effects of these unintended operational characteristics.

PHASE I: Research the system and software design process for a domain used for integrated platform combat systems or joint warfare coordination systems to investigate the cross pollination aspects, effect of limited modeling of system or software details, and the focus of design on good performance without addressing the implementation related side effects. Examine areas where system and software design can introduce these undesirable and unwanted side effects. Examine the major problems which are found in the implementation area since the implementation of the requirements is the most important area for evaluation of alternate paths, states, and unwanted modes of operation. Provide a report that documents the results of this investigation.

PHASE II: Develop procedures and processes which eliminate the source(s) of error or which allow the designer to find such types of errors in system or software design process(es) or models. Apply these new processes and techniques to a combat system or coordination system component(s) and provide a report on the results.

PHASE III: Take the results from Phases I and II and extend design processes using COTS to commercial systems.

COMMERCIAL POTENTIAL: Unintended paths and undesirable modes and states from these paths may be a major problem in commercial systems and COTS designs. The results of this research will raise the level of reliability and readiness of commercial system and make them more usable in defense systems.

KEY WORDS: Sneak paths; unintended operation; modes; states; system; software

N99-154 TITLE: Acoustic Technology Enhancement for 3" Countermeasures (CM).

OBJECTIVE: Analyze and develop an approach to replace current 3" CM electronic package with state of the art programmable processing technology in a 3" form factor for potential adaptive CM application.

DESCRIPTION: The Navy is interested in cost effective application of programmable/reprogrammable technologies that can be adapted for use in current and future 3" CM applications to mobile devices. Programmability envisioned is to be provided through a download link or as a reaction to receipt of signal of interest by the device itself. The new electronics when inserted in the device must be able to survive the current environmental conditions experienced during launch of the devices from Navy platforms.

PHASE I: Develop an approach to provide for a programmable form fit factor electronics board replacement of that contained in 3"CM with mobile capability. Identify and analyze current technologies that can provide current 3"CM with a direct replacement of electronics board with an electronics board containing processor(s), memory, and interface that permits reprogramming of device by the user, or as a result of acoustic emissions received. Acoustic technologies that can support the future establishment of a reactive capability are desirable and feasibility in the current 3" form factor should be identified.

PHASE II: Develop the performance, product integration requirements and design for fabrication and demonstration of Phase II programmable electronic board prototypes. Demonstrate design and integration compatibility of the prototype in a

3" mobile CM device. Complete the specification, design, and documentation for integration into a mobile 3"CM production devices to be provided under the Phase III project. Identify and analyze methods for incorporating reactive capability into mobile 3" CM devices. Develop Preliminary Engineering Change Proposal (PECP) for incorporation of reactive capability in future 3" CM devices.

PHASE III: Fabricate production models for technical and operational demonstration testing, including launch/deployment survivability, endurance and effectiveness in training and tactical environments. A final product specification shall be developed and delivered for initial production of an acoustically reactive mobile 3" CM device.

COMMERCIAL POTENTIAL: The programmable mobile 3" CM device has surface and subsurface application potential in Naval torpedo defense endeavors. The core programmable acoustic technologies resulting from this project have potential commercial application for maritime and various ocean systems including commercial fishing and remote operated vehicles. Adaptive acoustics may be applied as a relay for underwater communications or transmissions as well as off-shore oil and shipwreck explorations.

KEY WORDS: Acoustics, underwater, adaptive, echo repeat, countermeasure

N99-155 TITLE: Fiber Optic Depth Sensor for Towed Array Applications

SCIENCE/TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a passive fiber optic depth (pressure) sensor capability for towed array applications.

DESCRIPTION: The Navy is developing low cost passive optical acoustic sensor technology for use in future Navy towed arrays. To utilize these sensors in tactical arrays, a passive fiber optic depth (pressure) sensor is required, which has the following performance characteristics: 0 to 1000 psi absolute full scale pressure range; 0.001 psi max threshold; 2500 psia (for 1 hour) survival pressure; -2oC to +40oC operating temperature; -28oC to +65oC storage temperature. The pressure sensor will be ported out of the next assembly (the hose) and must sense the ambient hydrostatic pressure external to the hose. A co-located temperature sensing capability may be necessary to correct the pressure sensor data over some portions of its operating range. The sensor will operate in an ISOPAR L environment and should fit within a cylinder 0.76 inches in diameter and 4 inches long. The fiber optic pressure sensor should operate without requiring electrical power at the sensor element. It must be capable of passive optical interrogation over a fiber optic link up to 3 km in length. Additionally, the sensor approach must be capable of multiplexing such that at least 12 of these sensors may be interrogated over a single pair of single mode optical fibers. Interrogation of the 12 sensors over a single (single mode) optical fiber would be preferred.

PHASE I: Develop a prototype fiber optic pressure sensor which will meet the above performance and optical specifications. This prototype sensor may be a laboratory breadboard; however, the design must clearly be capable of meeting the mechanical and environmental requirements.

PHASE II: Develop and test a fully functional fiber optic pressure sensor. Deliver two individual sensors to the Navy for preliminary tow testing.

PHASE III: Produce pressure sensor suites for incorporation into military and civilian towed arrays.

COMMERCIAL POTENTIAL: These pressure sensors could be applied in any environment, which required the detection sensitivities described above. A passive fiber optic interrogation capability and the multiplexing of multiple sensors are needed in a number of EMI sensitive military and commercial applications.

REFERENCE: D. M. Dagenais and F. Bucholtz, Fiber-Optic Pressure Sensor Conceptual Study, Naval Research Laboratory Memorandum Report NRL/MR/5603--98-8104, March 31, 1998.

KEY WORDS: Pressure, depth, fiber-optic, sensors, towed arrays, multiplexing

N99-156 TITLE: Fiber Optic Rotary Joint

SCIENCE/TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a hybrid fiber optic/electronic rotary joint capability for a variety of Navy applications.

DESCRIPTION: The Navy is developing low cost passive optical acoustic sensor technology for use in future Navy towed arrays. To deploy these arrays from tactical platforms, a hybrid fiber optic/electronic rotary joint is required with the following capabilities/characteristics: at least 8 optical single mode fibers; 1530-1565 nm optical wavelength; 2.0 dB max optical loss per fiber; - 60 dB max optical back reflection per fiber; at least 2 electrical conductors; compatible with triaxial and coaxial cables having a 53 + 3 ohm characteristic impedance; 500 Vdc operating voltage; 2.0 amps operating current; 0.2 ohms max DC resistance; 0-30 MHz operating frequency range. The rotary joint shall perform in both static and rotating conditions (>300 rotations @ 30 rpm) during periods of continuous seawater immersion and periods of intermittent seawater immersion/air exposure. Finished housing dimensions must fit within a cylinder 5 inches in diameter and 8 inches long.

PHASE I: Develop a prototype hybrid fiber optic/electrical rotary joint which will meet the above performance and mechanical specifications. This prototype rotary joint may be a laboratory breadboard; however, the design must clearly be capable of meeting the dimensional and environmental requirements.

PHASE II: Develop and test a fully functional hybrid fiber optic/electrical rotary joint. Deliver one individual hybrid rotary joint to the Navy for preliminary tow testing.

PHASE III: Produce hybrid fiber optic/electrical rotary joints for incorporation into military and civilian towed arrays.

COMMERCIAL POTENTIAL: These hybrid fiber optic/electrical rotary joints could be applied in any environment that required passing optical and electronic signals through a rotating device. Hybrid electronic and fiber optic interrogation capability is needed in a number of military and commercial applications.

KEY WORDS: Slip ring, rotary joint, fiber-optic, towed arrays, hybrid fiber optic/electrical, acoustic arrays

N99-157 TITLE: Development of Low Cost COTS Technology for Total Ship Monitoring

SCIENCE/TECHNOLOGY AREA: Computers

OBJECTIVE: Develop a low cost total ship monitoring system to estimate acoustic radiation signature and to determine on board machinery condition.

DESCRIPTION: An important design consideration in the development of new naval ships is reduced detectability by threat sensors, including radar, ESM, infrared, and acoustics. The design and operational condition of propulsion and auxiliary machinery largely determine the acoustic visibility to a hostile ship. Existing systems are installed on some Navy ships to monitor acoustic radiation. These systems have been effective but have used customized sensors, transmission networks and processors. Many recent commercial technology improvements appear able to contribute to implementation and improvement of this monitoring capability. The Navy seeks feasibility demonstration of low cost commercial technology (sensors, signal conversion, interfaces, networking, and processing) which can provide TSM capability with minimal reliance on custom components. The system would provide two main functions: a far field estimate of the sonar vulnerability based on current ship vibration data, and a machinery monitoring capability for detecting equipment degradation. It would also be beneficial to exploit the extensive data bandwidth and processing capabilities of modern COTS equipment to provide significantly improved information about monitored components. Commercial processors may be able to exploit recent processing advances in machinery condition analysis that can help to reduce preventive maintenance or reduce shipboard manning. Offerors should provide a detailed system concept, identification of key components, proposed processing approach, and a plan for a portable, scalable software architecture. The architecture should utilize open industry standards to the extent possible with a feasible technology migration path. A prototype or other demonstration of the proposed architecture is required.

PHASE I: Develop a detailed monitoring system architecture including a cost and technical tradeoff of key components. The architecture should, to the maximun extebt possible use Open System Architecture Standards and COTS hardware. Provide a processing design description and preliminary computer sizing & timing analysis. Provide an analysis of total cost of ownership including procurement and Life Cycle Cost.

PHASE II: Build a prototype TSM system, based on the Phase I architecture, that demonstrates the architectural viability, including signal conversion transmission, data acquisition and signal processing. Demonstrate critical elements of the proposed design including data collection/acquisition, processing and timing.

PHASE III: Develop and install a prototype system, based on the Phase II prototype, which provides full system functionality. Install the prototype system on a vessel selected by the Navy. Collect data and analyze TSMS performance and report results. Develop system specifications and documentation and transition system to a production program. Potential transition programs include SSN Backfit (ARCI), Trident noise M Monitoring System, NSSN and SEAWOLF.

COMMERCIAL POTENTIAL: Real-time machinery monitoring has a huge potential commercial market. Many industries monitor machinery over very long duration with infrequent "signature samplings". Real-time monitoring helps to reduce repair cost by helping to identifying failing components long before costly catastrophic failures occur. Example industries include the automobile industry, steel manufacturing, appliance industry, and many others.

REFERENCES:
1. Rohrbaugh, R.A. "Advanced Time-Frequency Analysis: Theory and Application to Machinery Condition Assessment" Naval Surface Warfare Center Carderock Division, SADP-U93/00039-715 1 April 1993.
2. Forrester, B., "Time-Frequency Analysis in Machine Fault Detection," in Time-Frequency Signal Analysis: Methods and Application, B. Boashash (ed.), John Wiley and Sons, New York, 1992.

KEY WORDS: COTS; Low Cost; Real-time Processing; Machinery monitoring; Transient monitoring; Preventive maintenance

N99-158 TITLE: UUV Metal-Seawater Energy Source

SCIENCE/TECHNOLOGY AREA: Surface / Undersurface Vehicles

OBJECTIVE: Develop and demonstrate an SSN-compatible advanced metal-seawater electrochemical energy source for future Unmanned Undersea Vehicles (UUVs) having an energy density over 500 Whr/kg over a power density range of 1 to 100 W/kg.

DESCRIPTION: UUVs operate in the unique undersea environment. The use of sea-water as one of the reactants in the generation of electric or electrochemical energy enables high energy densities by eliminating the need to carry 100% of the consumable materials. The goal of this effort is to develop a metal-seawater cell energy source to meet the broad range of UUV power needs.

PHASE I: Identify and develop novel metal-sea-water electrochemical energy source(s). Fabricate lab-scale hardware and conduct a lab-scale tests to determonstrate feasibility and to define potential operating parameters for UUV operation. The development effort should quantify the potential performance payoff (energy density, power density) of the energy source by a combination of analysis and laboratory tests and provide experimental and analytical basis for further development in Phase II.

PHASE II. Phase I results must support a reasonable technical risk approach to meet a system energy density goal of over 500 Whr/kg over a power density range of 1 to 100 w/kg. A notional development plan for Phase II and beyond should be defined in Phase I.

PHASE II: Implement results and recommendations of Phase I analysis and test into scaled-up demonstration of the energy source at UUV operating parameters. Conduct further lab tests using Phase I test apparatus to define more optimun cell operating characteristics. Design, fabricate and demonstrate full-scale energy module operation (energy modules, cell stacks, subsystems) at UUV operating points(TBD). Demonstrate sub-scale or full-scale energy system operation, and pilot-scale manufacturing capability for UUV-unique energy system components.

PHASE III: Demonstration of energy source design and operation, and manufacturing processeses of critical UUV energy source components or elements will transition to the Government and acquisition program contractors. Mission Reconfigurable UUV (MRUUV) is the primary Navy program transition target.

COMMERCIAL POTENTIAL: The energy source technology has potential to greatly increase the commercial exploration of the oceans using autonomous vehicles (deep submersibles, ocean salvage, scientific exploration).

REFERENCES:

1.Enhanced Electrochemical Performance in the Development of the Aluminum-Hydrogen Peroxide Semi-Fuel Cell. E. Dow, et. al. Journal of Power Sources, 65 (1997)
2. A Solution Phase Catholyte Semi-Fuel Cell utilizing a Flowing Aqueous Electrolyte, 193rd Electrochemical Society Meeting, San Diego, May 3-8 1998, Dow and Medeiros.
3. U.S. Patent #5,718,986 (980217), ACells with a battery positive of hypochlorite or chlorite ion and anodes of magnesium or aluminum, Abner Brenner

KEY WORDS: undersea vehicles; UUV energy source; water-breathing propulsion; underwater propulsion; magnesium; sea-water batteries

BUREAU OF NAVAL PERSONNEL

N99-159 TITLE: Standardized Internet-Based Multimedia/Virtual Environment (MM/VE) Survey Interface

OBJECTIVE: To develop, test, and field a complete internet-based multimedia/virtual environment (MM/VE) survey system that uses a standardized intuitive human-computer interface.

DESCRIPTION: Survey technology is well developed for paper-and-pencil methods, however, survey administration by this traditional method is resulting in an increasingly low rate of return. Personnel may be inundated with multiple, time-consuming survey requests from which they receive little feedback. In addition, written questions alone may be ambiguous or subject to multiple interpretations despite careful pilot testing. Finally, paper-and-pencil surveys can ask a limited variety of question types. Internet technologies, including hypertext markup language (HTML) and virtual reality modeling language (VRML), and internet animation and graphics software, make new kinds of questions possible. These new question types hold the promise of engaging the participant while collecting new types of information. To capitalize on the promise of a marriage of these technologies with survey technologies, a simple standardized interface is required. Ideally, this interface will be incorporated into a survey software system that has, at a minimum, the additional security and tabulation features of the better survey software systems on the market today.

PHASE I: Design and perform a feasibility study exploring possible options and techniques for creating a standardized, intuitive human-computer interface for internet-based MM/VE surveys. The interface should anticipate the addition of new types of technologies. These should be incorporated as work progresses.

PHASE II: Develop a standardized human-computer interface for internet-based MM/VE surveys. Evaluate the ease of use and utility of the interface through testing with human subjects. Refine the interface and design and perform a preliminary test of the interface in a survey setting. Test the system both for functionality in a scientific survey and for intuitive user utilization. Design and perform a feasibility study for incorporating the interface into a survey software system.

PHASE III: Develop and test a prototype survey software system that incorporates the standardized human-computer interface developed and tested in Phase II. Produce and field a complete, upgradable, internet-based MM/VE survey system suitable for civilian as well as military use.

COMMERCIAL POTENTIAL: Surveys are an important descriptive research tool for the social sciences. As such, surveys are conducted both the military and civilian sectors. This technology will permit the scientific administration of new types of questions that can optimize the full potential of the internet.

REFERENCES: Sample U.S. Navy technical reports of recent organizational surveys can be provided upon request.
1. Earnshaw, R., & Vince, J. (Eds.) 1997. The internet in 3D: Information, images and interaction. San Diego, CA: Academic Press.
2. Norusis, M. J. (1997). SPSS 7.5 guide to data analysis. Upper Saddle River, NJ: Prentice Hall.
3. O'Rourke, D. (Ed.). (1992). Questionnaire formatting and demographic questions: Samples of questionnaires from academic/government survey organizations. Urbana, IL: Survey Research Laboratory, University of Illinois.
4. Rosenfeld, P., Edwards, J. E., Thomas, M. D. (Eds.) (1993). Improving organizational surveys. Newbury Park, CA: Sage Publications.
4. Sudman, S. (1976). Applied sampling. New York, NY: Academic Press.

KEY WORDS: interface; internet; multimedia; personnel; survey; virtual

N99-160 TITLE: Access Control and Personnel ID Verification for Training Applications Utilizing Smart Cards

OBJECTIVE: To develop Smart card technology that will provide id verification and access control to applications used in training environments.

DESCRIPTION: Smart Card technology provides a solution to a growing problem in the training industry. Situations exist where widely dispersed training audiences (particularly for WAN based applications) require various levels of access control to training materials. The use of a Smart card as a security access/user identity verification key provides an avenue to deliver distance learning applications in the right amount, to the right people. The Smart card provides a multitude of other benefits as well. These benefits could include access control to exercises based on proficiency ratings and certification for the completion of any prerequisites, as well as a vehicle to store student course transcripts. It could allow control of access based on personal data (such as rank/rate). The Smart card provides a means of physical control for access, making hacking impossible, since authentication is done at the card level and not through a centralized on-line system. With the addition of user identity verification, the card could be used as a key to activate the correct security levels as well. Smart Cards are currently used to provide easy control of encrypted files and Internet e-mail requiring physical control of the decryption mechanism.

PHASE I: Review the current Department of Navy uses for the Smart Card and determine what access controls are needed for current Navy training programs and future Advanced Distributed Learning programs.

PHASE II: Identify a Naval training program with access control and verification requirements. Design a multi-level security access and user identity verification system. Conduct feasibility study on the identified Naval training by implementing and testing Smart Card based access controls.

PHASE III: Pursue commercial application of products in industries requiring higher levels of security, such as the banking industry, university and college systems, Information Technology controlled products, and other access controlled environments.

COMMERCIAL POTENTIAL: Smart Card technology has tremendous potential in the commercial industry. Multi-level access control could be used as a key to internet authorization, bank-teller access, automatic check cashing machines, carrying updated medical information with limited access controls, university student id cards, etc.

KEY WORDS: Smart Card, Distance Learning, Access Control, Authentication

STRATEGIC SYSTEMS PROGRAM OFFICE

N99-161 TITLE: Low-Cost Fabrication of Multi-Use 3-D Carbon-Carbon Composites

SCIENCE/TECHNOLOGY AREA: Materials and Structures, Aerospace Vehicles

OBJECTIVE: Identify and demonstrate manufacturing technologies which reduce fabrication times and costs for 3-D carbon-carbon (C-C) composites.

DESCRIPTION: Current 3-dimensional (3-D) carbon-carbon (C-C) production processes are time consuming and costly (exceeding $1000/pound), limiting the usefulness of this material in many potential applications. An alternate, shorter time and lower cost *(ie., $100/pound goal)* fabrication process is desired. Minimum C-C property requirements are provided in Reference 1, p. 199. The alternate production process must be able to produce uniform density C-C in a size of at least 6 x 6 x 10 inches. In addition to the ability to produce C-C materials meeting minimum property requirements, it is desired that the alternate process be capable of producing higher strength C-C. Thus, a flexible fabrication process is desired which can provide higher, or lower, performance C-C materials at corresponding costs and fabrication times.

PHASE I: Develop a flexible production process for, and produce small quantities of, a C-C material. Obtain preliminary mechanical and thermal properties for the material to confirm meeting minimum property requirements (full characterization can extend into the phase II). Provide a cost comparison for the new vice existing fabrication process. Provide a detailed discussion/plan to show how the new fabrication process is sufficiently flexible to produce higher/lower capability 3-D C-C materials at commensurate cost and fabrication time.

PHASE II: Fabricate and characterize (mechanical and thermal properties) a range of C-C materials. The performance range of materials produced shall include military grade equivalent material. The material cost versus performance relationship shall be documented.

PHASE III: As needed, additional C-C materials shall be produced to complete the performance versus cost database.

COMMERCIAL POTENTIAL: Carbon-carbon materials are severely limited in market applications due to high cost. The current program would identify processing approaches to significantly reduce C-C cost to enable commercial product insertion. Commercial products include self-lubricating, high-temperature components (such as automotive pistons), human body implants, corrosion-resistant components for the chemical industry, and replacement of high strength graphite.

REFERENCES:. *Buckley, J.D., et al., Carbon-Carbon Materials and Composites, NASA Reference Publication 1254, February 1992.*

KEY WORDS: carbon-carbon composites, carbon fibers, weaving, braiding, pre-form construction, carbon-carbon composite processing.

NAVAL SUPPLY SYSTEMS COMMAND

N99-162 TITLE: Environmentally-Safe, Marine Disposable Gun Plugs

SCIENCE/TECHNOLOGY AREA: Material and Structures

OBJECTIVE: The purpose of this work is to develop and demonstrate gun plugs that can be safely disposed of in marine environments in accordance with MARPOL Treaty requirements and in land environments.

DESCRIPTION: Military operations require the use of gun plugs which function as a seal of the carriage case mouth in 5"/54 (and others) propelling charges. The plug also acts as a buffer for packing the projectile with propelling charge in the gun mount. The current materials used are 52% toluene diisocyanate (TDI) and 48% polyurethane resin. The current gun plug has the following specifications; but not limited to: Density 17 – 19.5 pounds per cubic foot. Compressive Strength mean greater than 500 psi with no value less than 425 psI. Shelf Life 20+ years in sealed magazine. Thermal Expansion_Not more than .03% at 50ºC after 24 hours. Voids Internal and external none greater than .125 inch length and .063 depth. Tensile Strength_mean greater than 375 psi with no less than 300 psi.

PHASE I: In Phase I, the contractor will demonstrate that gun plug 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 gun plugs can be fabricated. The contractor will subject the gun plugs to degradation testing. The contractor will also subject the gun plugs to laboratory and field testing to demonstrate that they can fulfill their intended purpose with all guns requiring such plug.

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

REFERENCES: Environmentally-Safe; Degradable; Gun Plug; Toluene Diisocyanate; polyurethane resin; Density.

N99-163 TITLE: Lightweight Firefighter's Boots Employing Modern Materials and Manufacturing Techniques

SCIENCE /TECHNOLOGY AREA: Materials/Manufacturing

OBJECTIVE: Develop a fire fighter's boot which will be significantly lighter in weight than the existing boot through the use of modern materials and manufacturing techniques. The resulting boot will improve fire fighter mobility and safety while reducing fatigue and improving mission effectiveness.

DESCRIPTION: The fire fighting boot used by the Navy at shoreside locations, training facilities and for damage control missions onboard ship is of the extremely bulky, heavy rubber variety worn by municipalities and volunteer fire departments. These firefighter boots are manually produced by building up many layers of die cut rubber on top of cushioning materials, such as felt, foamed rubber or fabric. Once the proper number of layers has been sandwiched and the sole applied, the boot is subjected to a heating process to bond the components together. Representative boots and manufacturers of the type described above are :

Firebreaker	Fire Tech	Flameguard
Norcross Safety Products	LaCrosse Footwear, Inc	Lehigh Safety Shoe Co.
Rock Island, Illinois	LaCrosse, Wisconsin	Endicott, New York
(309) 786-7741	(608) 782-3020	(800) 444-4354

The opportunity exists to replace this type of boot with a new and lighter design by leveraging more modern materials and production techniques widely available to the domestic boot industry. A basic approach might include the use of lightweight thermally stable plastics coupled with injection molding. It is envisioned that a weight reduction of at least 30% could be realized along with a 25% decrease in cost. The potential benefits for an improved fire fighter's boot are tremendous since this technological advancement would be enthusiastically received nationally by all fire fighting organizations, which in turn would further reduce cost. Since injection molding is prevalent in this country, competition to produce the boot would be increased resulting in an additional cost reduction.

PHASE I: Identification and selection of light weight materials and composites capable of meeting established National Fire Protection Association standards when incorporated into a fire fighter’s boot. Fabrication of first generation prototype boots to demonstrate cost effective manufacturing techniques suitable for preliminary laboratory testing against governing standards. Multiple concepts are encouraged to explore various approaches.

PHASE II: Refinement of prototype concepts and the manufacture of limited test quantities for multi-service user assessment.

PHASE III: Transition successful concept to production and commercial application.

COMMERCIAL POTENTIAL: The commercial potential for a fire fighter’s boot exhibiting a significant reduction in weight would be enormous since it would be embraced by fire fighters in both large municipalities as well as local volunteer fire departments. The benefit of this technological advancement would positively impact all fire fighters especially when a cost reduction is envisioned.

REFERENCES: National Fire Protection Association Standard for Protective Ensembles for Structural Fire Fighting (NFPA 1971)

KEY WORDS: Light Weight, Composites, Injection Molding, Flame Retardant, Fire Fighting, Protective Clothing

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N99-164 TITLE: <u>RF Bandpass Filters</u>

OBJECTIVE: To provide miniaturized high rejection RF bandpass filters.

DESCRIPTION: Current RF bandpass filters do not provide enough rejection in the frequency ranges above 1 GHz. New bandpass filters are required for these higher frequency ranges.

PHASE I: Design a high rejection RF bandpass filter, with a brick wall type of performance. Low insertion loss, significantly lower than 10 dB is desired. The dimensions of the filter should not exceed 1.5 cm in any direction . RF filters than can be built using monolithic substrate technology is desired to keep productin costs low. Model and simulate its performance. Prepare a technical report.

PHASE II: Build the high rejection RF bandpass filter designed in Phase I. Test the filter on a Government furnished antenna at a government laboratory. Prepare a report of the test results.

PHASE III: Install the high rejection RF bandpass filter on submarine antenna system. Perform Sea Trial testing. Prepare a report of results, and recommendations to improve performance.

COMMERCIAL POTENTIAL: Commercial satellite communication antenna systems.

KEY WORDS: RF, filters, antennas, SATCOM, UHF, RADAR

N99-165 TITLE: High Quality, Low Data Rate (LDR) Secure Voice

SCIENCE/TECHNOLOGY AREA: C3

OBJECTIVES: Provide high quality intelligible digitized secure voice at low data rate in Link 16 environment and in Link 16 platforms.

DESCRIPTION: Link 16 supports two secure voice circuits, each with 127 sub circuits. There are two principal Link 16 terminals: Joint Tactical Information Distribution System and Multi-Function Information Distribution System.

Each JTIDS terminal contains two 16 Kilobits voice encoders. At 8Khz sampling rate, these analogs to digital converter provide "voice recognition" quality communications. Unlike data in Link 16, the present digitized voice is not Reed-Solomon error encoded. Without Reed-Solomon, transmission errors are not corrected prior to conversion to audio or prior to retransmission for relay. Practical experience indicates that 16Kbps voice is understandable with up to 10% of bits in errors (Bit-Error-Rate BER= 10%). When operating in jamming or in low signal-to-noise ratio environment (Link 16 environments) relayed voice will become unusable first, followed by garbled direct voice, and unrecoverable data.

The next generation of the Link 16 terminal is the MIDS. MIDS voice capability is capable of implementing both 2.4KBPS and 16KBPS rates. With each of the implementation, there are selectable choice of Voice data rates (2.4, 4.8, 9.6, or 16), Error correction coding option (encoded or non-encoded), Message Packing limit and Time Slot assignment. With the 16KBPS selection, the MIDS will operate the voice channel as non-error coded and employs the continuous variable slope delta (CVSD). With the 2.4KBPS, the MIDS implement the National Security Agency (NSA) Linear Predictive Coding (LPC-10) (sampling rate of 8Khz). The current MIDS system segment specification calls for up to 5% BER. The probability of achieving a false correlation (on four consecutive synchronization pattern frame) is no less than 0.999. With this current implementation and if operate in the jamming environment where BER could be up to 10%, this implementation is not likely to achieve intelligent voice.

Currently in 1996, the Department of Defense Digital Voice Processor Consortium just named the Mixed-Excitation Linear Predictive Vocoder (MELP) as the new 2400 bits-per-second (bps) Vocoder Federal Standard. The MELP vocoder compresses the bit stream to 2400 bps, a significant 25:1 reduction. This voice may be acceptable in the laboratory where the jamming is unrealistic, however, in the Link 16 environment where jamming could potentially induced more than 10% BER (low signal-to-noise ratio) in addition to the ambient noise. In the MELP, the voiced portions of the bit stream have no error correction, but the unvoiced portions have forward error correction. The error correction cannot be removed. Without additional error correction, any errors will degrade the quality somewhat. Bit errors become intrusive over about 2%. Burst errors become intrusive at about 4%. If there is some sort of channel error indication, the burst errors become intrusive at about 10-15%, depending on the statistics of the bursts. At 10% BER, the voice become unintelligent. The additional protection scheme is needed to the MELP to handle up to 10% bit errors and more than 20% burst errors (without channel error indication). Even with breakthrough in this research, the approved MELP is only handling the peacetime environment where signal to noise ration is low and jamming is unlikely. Therefore, the MELP is an unlikely candidate for the jamming and in low signal-to-noise ratio (high BER) for the DoD Link 16.

PHASE I: Develop an advanced secure low bit rate and high BER tolerance (10% or more) speech coding algorithm that could reconstruct intelligent Link 16 voice. The algorithm should include the evaluation, examination, and comparison of alternative of existing potential algorithms such as MELP and Code Excited Linear Predictive Coder (CELP). The algorithm must be portable into existing structure of the JTIDS and MIDS with minimal impact. The Mean Opinion Score (MOS) score must be at least 3.3 or better (higher).

PHASE II: Implement and test the algorithm in a Link 16 operational environment.

PHASE III: Develop a transition plan for integration into the JTIDS, MIDS, and future Link 16 terminal.

COMMERCIAL POTENTIAL: There are numerous commercial applications ranging from aircraft to highway vehicles.

KEY WORDS: Anti-Jamming, Low Bit Rate, Speech Coding, Secure Voice, Link 16, High BER, Secure Voice.

N99-166 TITLE: Miniature Antennas For Submarine Advanced Buoyant Cable Systems

OBJECTIVE: Develop miniature RF antennas that can be located in a small surface towed module that is part of a buoyant cable antenna system which is deployed and retrieved from a submerged submarine. These secondary payloads will augment the operation utility of the module and fit within the residual payload envelope.

DESCRIPTION: Submarines currently use buoyant cable antenna system to provide limited RF communications capabilities while at operating at various speeds and depths. This effort will develop the size, shape, and performance of antenna concepts that could be part of the buoyant cable system to add capability. The antennas can be located either within or deployed and retrieved from a small buoyant module located at the end of the buoyant cable. The antennas must be small and operate over a seawater ground plane in low and high sea states. Antennas can address frequency bands within the following areas; RF (UHF-EHF transceive), ESM (2-40 GHZ receive), and Navigation (GPS receive). This effort would establish antenna concepts, size, shape and RF performance through analysis, scale models and testing. Evolving commercial telecommunication satellite system requiring very small antenna systems, such as Iridium and Teledesic are potential future communication links.

PHASE I: Identify miniature antenna concepts that can provide installed in a buoyant cable system and provide RF capability. Conduct analysis to establish antenna shapes, sizes, and RF performance.

PHASE II: Develop full size models of selected antennas and conduct laboratory RF tests to validate analysis performed in Phase I.

PHASE III: Develop full size model of selected antennas and conduct tow testing of antennas to establish RF and hydrodynamic performance characteristics.

COMMERCIAL POTENTIAL: Evolving commercial telecommunications, telemetry and navigation satellite systems are targeting handheld, portable, and mobile mounted connectivity applications at rates up to and beyond T1. Antennas developed to link to these systems for a buoyant cable antenna module have potential for transition into compact consumer products.

REFERENCES: ONR technical reports/briefings on 6.2 effort for the Low Profile Antenna and DARPA technical reports/briefings for the Buoyant Cable Antenna Array. Iridium worldwide phone/paging system, INMARSAT C paging and Global Positioning System are candidate systems.

KEY WORDS: Antennas; Miniature; RF; Submarine; Analysis; Models

N99-167 TITLE: Intelligent Agent Security Module

OBJECTIVE: Develop an intelligent module to allow interoperation with Automated Auditing Tools, Intrusion Detection Systems, firewalls and other NVI security solutions.

DESCRIPTION: Investigate COTS products for real-time automated auditing collection and reduction and for real time intrusion detection collection and interpretation. Based on the limitations of available technologies, develop an intelligent agent module to utilize current and future automated collection and reduction tools and to utilize current and future intrusion detection collection and interpretation tools. The intelligent agent module will integrate inputs from audit reduction, intrusion detection and all other security functions using an adaptive wrapper scheme to communicate with the intelligent agent. The inputs will be utilized to develop user profiles and compare system usage against prescribed NVI policies to automatically identify potential threats to information systems. The nature of the information collected and presented by this intelligent agent security module will lend itself to system administrator functions well beyond security. Besides overall workload reduction for the system administrator, the agent will be able to assist in functional areas such as Configuration Management and Asset Allocation.

PHASE I: Develop adaptable wrappers to allow COTS products to interact with intelligent agent. Develop intelligent agent structure for use in development in Phase II.

Investigate existing technologies suitable for application in an intelligent agent security module and identify policies and user profile parameters. Perform laboratory demonstration of developed adaptable wrappers at small business location. Utilize Phase I option of additional funds to provide a demonstration of communications with COTS products via use of developed adaptable wrappers in a government facility to be identified.

PHASE II: Develop the intelligent agent security module. Integrate the adaptable wrappers/COTS demonstration from Phase I with the intelligent agent and demonstrate the full capability of the intelligent agent security module in a testbed facility to be designated by the government.

PHASE III: Contingent upon a successful demonstration in Phase II, develop the intelligent agent security module in a form factor suitable for integration with the NVI initiative and for marketing as a potential commercial product.

COMMERCIAL POTENTIAL: Corporations are aggressively pursuing solutions to reduce security vulnerabilities associated with their information network systems and provide automated intelligent assistance to their system administrators. Automating technologies and intelligent agent modules as described above would have direct and immediate application in commercial environments.

KEY WORDS: intelligent agents, intrusion detection, audit reduction, firewall, Network Operation Center, security vulnerabilities, COTS products

N99-168 TITLE: Optimal Integration of Multi-functional Information Distribution System (MIDS), Inertial Navigation Systems (INS), and Global Positioning System (GPS)

OBJECTIVE: Optimize the availability of GPS quality position, velocity and time information for use in a host of electromagnetic environments and to provide a secure link for precision aircraft landing.

DESCRIPTION: Commercial and military applications are increasing reliance on GPS to provide accurate position, velocity and time measurements to meet operational requirements. The FAA has approved the use of GPS for en-route navigation and the military and civil users are considering using GPS for precision aircraft landing. As applications that use GPS increase in complexity, the vulnerabilities of GPS become significant. This effort would use existing technology and information available in MIDS, INSs and GPS to provide a robust/optimal secure position, velocity and time source to meet the needs of the military user in a hostile electromagnetic environment foremost and the civil/military user in precision aircraft landing.

PHASE I Establish requirements and design an optimal (sub-optimal) external Kalman Filter that combines raw measurements from MIDS, INS and GPS. Develop an applique to transmit this AGPS Quality position, velocity and time information to a user who requires GPS accuracy. Examine the feasibility, utility, and effectiveness of the filter and transmission vehicle. Prepare concept of operations and analysis of alternatives paper addressing civilian and military utility.

PHASE II: Apply the results of Phase I to develop and test a proof-of concept prototype low cost MIDS Applique Receptor. Validate the effectiveness of the concept.

PHASE III: Apply the results of Phase I and II to produce and integrate the AGPS Quality Applique in a full scale operational environment.

COMMERCIAL POTENTIAL: This system will provide an effective and secure source of GPS quality position, velocity, and time information for precision landings of civilian and military aircraft.

REFERENCES:

1. GPS/JTIDS/INS Integration Study Final Report, Draper Laboratory, June ‘78;
2. Decentralized Relative Navigation and JTIDS/GPS/INS Integrated Navigation Systems, Widnall et al, MIT, January ‘82

KEY WORDS: MIDS; JTIDS; GPS; INS, Navigation, Positioning, Fix Taking

N99-169 TITLE: Distributed Inertial Sensor Tactical Navigation Tool (DISTANT)

OBJECTIVE: Develop an inertial navigation system augmentation employing spatially distributed sensors in combination with advanced computational techniques.

DESCRIPTION: With the latest advancement in accelerometer technology (including micro-electromechanical accelerometer technology), reliable, small-sized and low-cost accelerometers are readily available. In contrast, small size, low-cost gyros have yet to demonstrate inertial navigation grade performance. The availability of multiple distributed accelerometers will allow construction of improved navigation systems.

PHASE I: Establish requirement and conduct initial analysis of improvements to be expected in gyro accuracy using spatially distributed low cost accelerometers to enhance gyro accuracy. The analysis should examine enhancements to be gained using multiple accelerometers in some optimally distributed configuration in selected Naval platforms to provide improved INS performance. The number of accelerometers, geometrical configurations, and computational techniques shall be studied. Design a prototype inertial navigation system.

PHASE II: Apply results of Phase I, perform computer simulations to bound the performance characteristics of the prototype configurations. Evaluate available low-cost inertial sensors, which can support selected configurations. Develop a prototype for a selected Navy platform as recommended in Phase I. Conduct concept demonstration and testing in a laboratory and on an operational Naval vessel.

PHASE III: Apply the results of Phase I and II to produce and integrate the navigation tool into an operational system.

COMMERCIAL POTENTIAL: Applicable to various commercial applications where GPS navigation is used; e.g., Satellites, commercial space lift vehicles, commercial aircraft, etc.

KEY WORDS: Distributed; Inertial; Sensors; GPS; Navigation; Accelerometers; Gyroscope

N99-170 TITLE: Interactive Human Systems Interfaces and 3D tools for Information Warfare Systems

SCIENCE/TECHNOLOGY AREA: Computers, Software

OBJECTIVE: To develop a set of 3D tools that will provide an innovative user interface for effective use of information. This information is typically collected by a sensor and analysis system and provided to a command and control infrastructure for information or action.

DESCRIPTION: Although communications intercept systems can provide battlespace information, the user interfaces on most of these systems primarily support collection and analysis of various type of signals intelligence. To be useful as weapons in the command and control infrastructure, these information collection systems must support a different set of functions and must provide effective interfaces for information weapons systems. Functions include: 1) IFF and target selection; 2) easily understandable representation of the current battlefield situation (e.g. damage assessment), and 3) decision support in a rapidly changing and complex environment. The user interface must both optimize IW mission effectiveness and be consistent with integrated C4ISR and combat systems under the various DII COE (Defense Information Infrastructure Common Operating Environment) standards. The current DII COE standards build primarily on commercial 2D applications. In line with the overall Joint Technical Architecture (JTA) and the DII COE, several programs and R&D initiatives are generating 3D type applications. In addition, the need to prevent user interface problems for IW and other applications highlights the need for Navy 3D Tactical Data Symbology. These developments could be expanded to a 3D Joint Mapping toolkit as part of a consolidated set of 3D libraries. The set of 3D libraries, specific to DOD mission critical applications, could complement current commercial libraries. These sets of 3D tool kits could also minimize duplication of development and reduce overall DOD 3D visual software development cost.

PHASE I: Investigate current commercial packages to be leveraged to support various standard operating environments such as UNIX, NT, and Java. Design and prototype an innovative battlefield visualization and decision support interface for Information Warfare Systems.

PHASE II: Design, develop and evaluate a user interface, based on the technology used in Phase I, that can be incorporated into an existing Information Warfare system. The system should be evaluated for efficacy, ease of use, and compatibility with the underlying Information Warfare System. Apply the results of Phase I to develop beta libraries. Distribute to select list of DII COE development community for feedback and assess supportability.

PHASE III: Applying the results of Phase I and II, produce an initial release library package and provide it to DISA DII COE for implementation and release to the DII COE development community. Host the prototype interface system and tool set to participate in a full up field evaluation.

COMMERCIAL POTENTIAL: Similar interfaces and 3 D tool sets will be required by numerous agencies (Coast Guard, major city police headquarters operations, counter-narcotic operations, other government agencies) operating sensor and information Command Centers. These 3-D tool sets will also have widespread application for operations and maintenance of advanced wireless telecommunications networks to identify network vulnerability and intrusion detection.

REFERENCES: DD-21 Opsits, DD-21 Mission Needs Statement

KEY WORDS: Information warfare; decision support; data visualizations; command and control infrastructure; software libraries, 3 dimensional, METOC, Displays, C^4ISR, DII COE

N99-171 TITLE: Near Real Time Modeling of Cable and Sensor Orientation on the Ocean Floor after Near Bottom Installation

OBJECTIVE: Develop efficient and reliable real time algorithms for determining the as-deployed location of fiber-optic micro-cable(s).

DESCRIPTION: With the increasing use of fiber-optic micro-cables by the U.S. Navy, an accurate real time determination of where these cables have landed on the sea floor is required. Future undersea surveillance fiber-optic micro-cables and acoustic arrays will be deployed from an underwater towed vehicle operating near the ocean floor. The knowledge and understanding of the geographical position, line-of-bearing accuracy and straightness of the arrays after they are laid is critical to their performance in detecting and tracking targets. The physical ocean environment and positions of the deployment vehicles during the installation process determine the final placement of the cables and arrays. The current profile that exists between the deployment point and ocean floor will affect the bottom location and shape (slack) of arrays and cable. The bathymetry of the ocean also affects how the cable will be laid on the sea floor. Therefore, the operator of the underwater vehicle continuously evaluates the current profile, ship's speed, bathymetry and other sensor inputs. Effective adjustments in the underwater vehicle depth, tow speed, and heading could be made to eliminate or reduce undesirable current effects if the effects could be assessed in real time.

Current program(s) can provide non-real time estimates of cable/array shape on the bottom. The software now in use (ATrac-Time Domain Response Analysis of Cables or FOCAL-P) requires extensive off-line post-processing to provide estimates of cable posture on the bottom. Additionally, it relies on fixed, manual parameter inputs. This is clearly not adequate for the deployment of fiber-optic micro-cable from surface and subsurface vehicles

PHASE I: Determine the feasibility, establish requirements, define concept, and develop preliminary designs for a real time algorithm for submerged fiber-optic micro cables locating. Conduct analysis of existing submerged cable locating algorithms and models to better understand their ability to meet the established requirements. This analysis should include verification of accuracy; development of interfaces for the automatic, real time input of variables such as cable parameters, bathymetry, ship and underwater vehicle position, underwater vehicle depth, and current profile; and optimization of the model to run efficiently and in real time.

PHASE II: Develop a proof-of-concept algorithm to run on various platforms. Test the proof of concept against the requirements established in Phase I in the operational environment to include participation in at sea optimization of the micro-cable installations.

PHASE III: Apply results of Phase I and II to produce a reliable real time algorithm for operational undersea fiber-optic micro-cable locating. Integrate the capability into deployed control and monitoring equipment used to deploy surface and sub-surface fiber-optic micro-cables.

COMMERCIAL POTENTIAL: These improved algorithms could be applied to commercial programs that install submarine cables that require real time assessment of where the cable(s) has been laid. This is particularly applicable to the commercial telecommunications industry and another industry where undersea optical cables may be deployed.

KEY WORDS: Fiber-optic; micro-cable; installation, computer, current; undersea locating

N99-172 TITLE: Secure Voice Over Wide Area Networks

SCIENCE/TECHNOLOGY AREA: Command, Control, & Communications

OBJECTIVE: Enable secure voice communications over Internet Protocol (IP) and asynchronous transfer mode (ATM) networks, including networks over satellites and other radio frequency (RF) links. Provide full 2-way dialog for unicast and multicast modes

DESCRIPTION: Past secure voice communications have used dedicated circuits. The military is now transforming these dedicated circuits into IP-based networks, allowing many functions to share the same network capabilities. Certain high-bandwidth circuits will use ATM technology, with the IP network sharing the ATM network with other communication forms. Although these new communication technologies are essential to accommodate the anticipated growth of military needs, they must be implemented in a way that is transparent to the users. Some users need to talk person-to-person (unicast mode) while others need to communicate to many users over a common network (multicast mode). The Navy, in particular, is dependent on networks that use RF links. These RF links are subject to bandwidth constraints and circuit noise. The solution must take these factors into account.

PHASE I: Develop a detailed system architecture that meets the objective needs of the military. This entails the identification and development of technology that performs the security functions, and may include the ordering and distribution of supporting key material, over the relatively narrow band radio frequency connections available to Navy units.

PHASE II: Develop and demonstrate the system over Navy Wide Area Networks. This requires the development, integration, implementation and demonstration of the architecture described in the first phase. Included are the development of the implementing products for the voice communications security functionality (including the speech digitization and the security algorithm), the network controlling elements (to guarantee the real time nature of secure voice), and the key management and distribution elements. It is desired that the implementation be demonstrated to be interoperable with existing secure voice systems, such as STU-III, ANDVT, KY-57/58, etc.

PHASE III: Contingent on a successful demonstration, develop and produce the next-generation Navy secure voice over networks system. The production system must be made easy to use, easy to maintain, and supportable in a military environment. The production system will be used in the Automated Data Network System (ADNS) and the Base Level Information Infrastructure (BLII) if successful.

COMMERCIAL POTENTIAL: While commercial products have demonstrated voice transmission over Internet Protocol networks, none of these products are secure. Both the secure encoding and the call establishment must be made in real time. It is known that establishing a secure voice connection over Navy wide area networks is non-trivial. Although there may be commercial products embedded in the final solution, the system itself will entail substantial development in order to be workable. No commercial items exist that do all of the functions known to be needed, nor are the products that do small pieces of the required functionality sufficiently compatible to be integrated directly. For example the required one-to-many mode of operation is particularly challenging as none of the commercial items directly respond to this requirement. Formulating the detailed system architecture will require substantial research and development effort to define a workable system design having the needed security attributes.

DUAL USE: The application of this system capability for commercial requirements is potentially large. Industry is already investing in commercial intranets to integrate and maintain their information infrastructures. Although military level security is not necessarily needed, a high degree of privacy is required to protect their proprietary advantage in the market. Like so many things in the security area, items developed with military use in mind are desired in the commercial market. Although a separate key management infrastructure will be required, and potentially some encryption algorithms may need to be protected or restricted, the technology developed will in general be directly transferable to commercial sector use.

KEY WORDS: secure voice; voice over IP; voice over ATM; voice over data networks; satellite communications;

N99-173 TITLE: <u>Cryptologic Component Architecture</u>

SCIENCE/TECHNOLOGY AREA: Computers, Software

OBJECTIVE: Provide a new and innovative ultra high speed digital processing server for use with an array of integrated IO-Exploit, IO-Attack and IO-Defend software client components.

DESCRIPTION: Over the past few years, costs and schedules for development, testing, maintenance, and training have increased significantly, while the Navy's R&D budget has declined. The proposed technology will provide better ways to develop these Information Warfare systems, reduce costs, and provide increased flexibility for the user. This technology will produce a substantial reduction in technology transition time and life cycle costs. The architecture shall demonstrate sufficient flexibility to meet the broad needs of existing applications and to grow as needed to support new requirements.

PHASE I: The Phase I investigation will develop approaches that consider capacity and throughput requirements for existing and planned applications, their underlying components, and component commonality within and across Navy Information Warfare systems. The contractor will investigate various standards and develop an approach utilizing those enabling standards considering key throughput performance requirements, capacity flexibility, and the potential use of NDI products. The report of the Phase I effort should include a well defined and justified approach for developing a suitable digital processing engine that is capable of sustaining the real time throughput and capacities required for the Joint Maritime Information Operations System (JMIOS).

PHASE II: During Phase II, the contractor will produce a common baseline prototype of digital processing components and clearly defined APIs using the proposed architecture of phase I and demonstrate their integration into a COBLU or JMIOS. The developed architecture will be evaluated for its ability to implement common software processes and products. The contractor will refine key performance parameters, provide a complete set of components, associated documentation and training materials consistent with best commercial practices.

PHASE III: Team with a manufacturer or supplier to transfer and fully integrate the design into the JMIOS design, development and production.

KEY WORDS: JMIOS, Information Operations, Software, Object-Oriented Design, and Digital Processing Componentware.