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. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **2 December 2002.** For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST).

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I PROPOSAL SUBMISSION:

Read the DoD front section of this solicitation for detailed instructions on proposal format and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. 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 address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. Phase I proposals, including the option, have a 25-page limit (see section 3.4). 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. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

ALL PROPOSAL SUBMISSIONS TO THE NAVY SBIR PROGRAM MUST BE SUBMITTED ELECTRONICALLY.

It is mandatory that the complete proposal submission -- DoD Proposal Cover Sheet, **ENTIRE** Technical Proposal with any appendices, Cost Proposal, and the Company Commercialization Report -- be submitted electronically through the DoD SBIR website at http://www.dodsbir.net/submission. Each of these documents is to be submitted separately through the website. Your complete proposal **must** be submitted via the submissions site on or before the **5:00pm EST, 15 January 2003 deadline.** A hardcopy **will not** be required. Signatures are not required at proposal submission when you submit your proposal over the Internet. If you have any questions or problems with electronic submission, contact the DoD SBIR Help Desk at 1-866-724-7457 (8am to 5pm EST).

Acceptable Format for Online Submission: All technical proposal files must be in Portable Document Format (PDF) for evaluation purposes – do not lock/protect your pdf file. The Technical Proposal should include all graphics and attachments, but not include Cover Sheets. You are required to include your company name and topic number as a header in your technical proposal document. Cost sheets can be included in the technical proposal or submitted separately through the form available through this website. Technical Proposals should conform to the limitations on margins and number of pages specified in the front section of this DoD Solicitation. However, your Cost Proposal will only count as one page and your Cover Sheets will only count as two, no matter how they print out. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each submission to avoid complications or delays in submitting your Technical Proposal. To verify that your proposal has been received, click on the "Check Upload" icon to view your proposal. Typically, your proposal will be uploaded within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk. It is recommended that you submit early, as computer traffic gets heavy nearer the solicitation closing and slows down the system.

Within one week of the Solicitation closing, you will receive notification via e-mail that your proposal has been received and processed for evaluation by the Navy. Please make sure that your e-mail address is entered correctly on your proposal coversheet or you will not receive a notification.

PHASE I ELECTRONIC FINAL REPORT:

All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I. The Phase I Summary Report is a non-proprietary summary of Phase I results. It should not exceed 700 words and should include potential applications and benefits. 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".

ADDITIONAL NOTES:

The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funding that a firm has received based on technology developed from a Navy SBIR or STTR Phase II award. The success stories should be included as appendices to the proposal. These pages will not be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company's Commercialization Report and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them. Phase III efforts should also be reported to the Navy SBIR program office noted above.

NAVY FAST TRACK DATES AND REQUIREMENTS:

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Navy SBIR Program Manager at the address listed above, to the designated Contracting Officer's Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Navy Activity SBIR Program Manager listed in Table 1 of this Introduction. The information required by the Navy, is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

PHASE II PROPOSAL SUBMISSION:

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 that Activity's proper point of contact, listed in Table 1, during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award. If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in Table 1. 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). The Navy typically provides a cost plus fixed fee contract or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) A base effort, which is the demonstration phase of the SBIR project; 2) A separate 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market and transition your technology to the government, government prime contractor, and/or private sector; and 3) At least one Phase II

Option which would be a fully costed and well defined section describing a test and evaluation plan or further R&D. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. **Each of the Navy Activities have different award amounts and schedules; you are required to get specific guidance from that Activity's SBIR Program Manager before submitting your Phase II proposal**. Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). The Transition/Marketing plan must be a separate document that is submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir** under "Submission" and also included with the proposal submission online. All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the Navy Activity specified deadline. The Navy Activity that invited your PH II may also require a hardcopy or your proposal.

All Phase II award winners must attend a one-day Commercialization Assistance Program (CAP) meeting typically held in the July to August time frame in the Washington D.C. area during the second year of the Phase II effort. If you receive a Phase II award, you will be contacted with more information regarding this program or you can visit **http://www.navysbir.com/cap**.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results. It should not exceed 700 words and should include potential applications and benefit. It should require minimal work from the contractor because most of this information is required in the final report.

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional SBIR funds for $1,000,000 match of acquisition program funding, can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

Effective in Fiscal Year 2000, a Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. The governments prime contractors and/or their subcontractors will follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect data rights of the SBIR company.

TABLE 1. NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT (POC) FOR TOPICS

Topic Numbers	Point of Contact	Activity	Phone
N03-001 thru N03-006	Mr. Rod Manzano	MARCOR	703-432-3295
N03-007 thru N03-034	Mrs. Carol Van Wyk	NAVAIR	301-342-0215
N03-035 thru N03-036	Mr. Nick Olah	NAVFAC	805-982-1089
N03-037 thru N03-089	Mr. Dick Milligan	NAVSEA	202-781-3747
N03-091 thru N03-099	Mr. Ron Vermillion	ONR1	540-653-8906
N03-100 thru N03-141	Mr. Douglas Harry	ONR2	703-696-4286
N03-142 thru N03-152	Ms. Linda Whittington	SPAWAR	858-537-0146
N03-153 thru N03-155	Mr. Dave Dugan	SSP	202-764-1554

Do not contact the Program Managers for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 1 October until 2 December 2002. These topic authors are listed on the Navy website under “Solicitation” or the DoD website. After 2 December, you must use the SITIS system listed in section 1.5c at the front of the solicitation or go to the DoD website for more information.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

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

____1. Make sure you have added a header with company name and topic number to each page of your technical proposal.

____2. Your technical proposal has been uploaded. The DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 5:00 p.m. EST 15 January 2003.

____3. After uploading your file and it is saved on the DoD submission site as a PDF file, review it to ensure that it appears correctly.

____4. The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy 03.1 Topic List

N03-001	Field Chemical Analysis Tool
N03-002	Extending the Life of Biosensors with Dendrimers
N03-003	Single Component, Zero Volatile Organic Compound, Chemical Agent Resistant Coating
N03-004	Lightweight, inexpensive, corrosion inhibiting integral and/or multi-component ElectroMagnetic Interference (EMI) and environmental seals for Advanced Amphibious Assault Vehicle (AAAV)
N03-005	Polymer-Cased Ammunition for Small Arms and Cannon Ammunition
N03-006	Single Component, Zero Volatile Organic Compound, Chemical Agent Resistant Primer
N03-007	Improved Propeller De-Icing Systems
N03-008	Passive Rocket Motor Identification
N03-009	Ultrapure, Spherical, Monodisperse, Unagglomerated Nanopowders for Infrared Window Materials
N03-010	Innovative and Scalable Near Net-Shape Manufacturing for Shape-Memory Alloy
N03-011	Non-Polymer Optical Fiber Coatings
N03-012	Damage Characterization and Remaining Life Assessment of Materials
N03-013	Optimum Polarimetric Radar Imaging System for Automatic Wake Detection Algorithms
N03-014	Air Antisubmarine Warfare (ASW) Environmental Characterization using Existing Tactical Sensors
N03-015	On-Board Wind Vector and Air Density Sensing for Weapon Applications
N03-016	Intelligent Test Data Analysis Technology (IT-DAT)
N03-017	Automated Generation of Usability Prototypes and Tactical Software
N03-018	High-Speed Portable Nondestructive Inspection of the Inside Surface of Pipes and Tubing for Corrosion (and Cracks)
N03-019	Real-Time Inspection of Fasteners in Aerospace Structures
N03-020	Novel Main Transmission Design Concepts
N03-021	Reduction of Rotary-wing Aircraft Driveshaft Deflection via Damping
N03-022	Automated Interoperability Testing System
N03-023	Digital Input/Output (I/O) Bus for Simulators
N03-024	Wide Field-of-View, Head-Mounted, Visor Optics
N03-025	Motion Imagery Navigation

N03-026 Imagery Automatic Extraction/Precision Placement of Cultural Features

N03-027 Useful Life Remaining Models for Turbine Engine Hot Section Components

N03-028 Fault-to-Failure Progression Modeling of Propulsion System and Drive Train Clutch Systems for Diagnostics, Prognostics, and Useful Performance Life Remaining Predictions

N03-029 Acoustic Emission Monitor for Drive System Coupling Crack Detection

N03-030 Increased Impact Protection of the Navy's Aviator Helmets

N03-031 H-60 Mission Avionics Technology Insertion

N03-032 Sonobuoy Launcher

N03-033 Mid-Frequency Sonobuoy

N03-034 Advanced Multi-Aircraft Shipboard Landing Model

N03-035 Development of a Crack Resistant Durable concrete Repair Material for Navy Concrete Structures

N03-036 Microturbine Fuel Pump Life Extension

N03-037 Data Model for Battle Force Interoperability Certification

N03-038 Computer Aided Identification of Mines

N03-039 Alternative System for Hangar Bay Access Doors

N03-040 Alternative Drive System For Deck Edge Elevator

N03-041 Acoustic and Electro-Optic Data Fusion

N03-042 High Efficiency Mission Performance for Underwater Expendable Countermeasure Devices Commonality Applications

N03-043 High Sensitivity, Pressure Compensated Optical Hydrophone

N03-044 Develop and Evaluate Alternative Hullform Technology for the 11 Meter Ridgid Inflatable Boat

N03-045 Knowledge Gathering Network for BFMIS

N03-046 Logistics Support Systems using Advanced Multimedia Technologies

N03-047 Low Cost Submarine UAV Communications and Sensor Data Link

N03-048 Low Cost Electronics System for Large Sonar Arrays

N03-049 System Automation That Will Support Reduced Manning On Submarines (Component-Level Distributed Control System Technology)

N03-050 Innovative and Non-invasive Heat Load Removal of Electronic Components/Computers

N03-051 Low Cost Non-Explosive Shock Qualification Testing

N03-052 Air Blast & Ballistic Impact Damage Evaluation of Marine Composite Structures

N03-053 Waste Heat Conversion Techniques for Power Electronics

N03-054 Nanocrystalline Materials to improve Thermoconductivity of Heat Pipes

N03-055 Advanced Thermal Management for High Heat Flux Power Electronic Modules

N03-056 Robust Open Systems Architecture Surface and Underwater Vehicles Stern Launch/Recovery System

N03-057 Automated Open Systems Architecture Shipboard Handling and Stowage System for Organic Offboard Vehicles

N03-058 Advanced Ship/Fixed-wing UAV Recovery Interface

N03-059 Ship Motion Effects on Human Performance

N03-060 Methods & Metrics to Measure the Impact of Knowledge Superiority Technologies on the Warfighter

N03-061 Simulation of Low Frequency (< 2 GHz) EMI and Coupling in Shipboard Environments

N03-062 High Frequency (> 2 GHz) Inter-Aperture Direct Coupling and Radiation

N03-063 Affordable, Flexible, Network Capable Application Processor for Data Acquisition and Processing

N03-064 Kinetic Energy Penetrator Payload for EX 172 Cargo Round

N03-065 Gradiated Gun Barrel Fabrication Process

N03-066 Hot Gun Barrel Detector for Navy Guns

N03-067 Pre-fragmented Warhead Plate for EX 171 ERGM

N03-068 Term Geo-Political Context Decision Support Tool

N03-069 Optimal Manning Analysis Tool for Grouped Forces

N03-070 Beam Control (BC) for Ship Self-Defense

N03-071 Broadband Processing for Mine Warfare Sonar

N03-072 Strong Torpedo Fiber Optic Communications Link

N03-073 Submarine Emulsified and Mixed Hydraulic Oil Cleaning, Filtration and Reuse Aboard Ship

N03-074 Development of a Supportability Performance Assessment System for Training Systems

N03-075 Development of an Advanced Thermoelectric Cooling System for Unmanned Underwater Vehicles (UUVs)

N03-076 Advanced Digital Array Radar (DAR) Adaptive Beamformer and Pulse Compression Processor

N03-077 Advanced Engineering Application Integration Technologies

N03-078 Metal Passivization to Resist Corrosion

N03-079	High Performance Secure Shipboard Network For Wireless/Wired Connectivity
N03-080	Radome Materials & Process for Long Flight Duration-High Speed Missiles
N03-081	Uncooled Infrared Focal Plane Array (IR FPA) Window
N03-082	Electronic Sensor Precision Feature Extraction Pre-processor
N03-083	Wideband Limiter Protector for radar and electronic warfare systems
N03-084	Radar Power Sources and Power Conditioning
N03-085	Multi-Component / Integrated Pulse Analysis Display Capability For Electronic Warfare Systems
N03-086	Permanent Magnet Motor Steering Gear
N03-087	Rapid Deterministic Fault Detection in Distributed Systems
N03-088	Systematic Verification of Real-Time Interfaces Under Stress
N03-089	Applying Fine Water Mist (FWM) Technology to DDG 51 Class Ships
N03-091	Improved Efficiency Broadband Amplifiers
N03-096	Short-Duration Manually-Driven Electrical Power Sources
N03-097	Ultra-Wideband High-Efficiency Low-Profile Antennas
N03-098	Development of New Program-Specific Geometry Models
N03-099	Acoustic noise reduction for large aircraft
N03-100	Technologies to Support RO/RO Cargo Transfer in Sea State 5
N03-101	Enabling Hull Structural Innovations for High-Speed Lighters
N03-102	Compact Actuator System
N03-103	Active Cooling of High Heat Electronic Components
N03-104	Low Drag Multi-Frequency Radome
N03-105	Technology for Shipbuilding Affordability
N03-106	Efficient Reuse of Ontologies for Multi-Agent-Based Decision Support Systems
N03-107	Quantum Cascade Lasers
N03-108	Compact Channelizing Filter Banks for Receiver Arrays
N03-109	Single Channel Ground Moving Target Indication (GMTI)
N03-110	Sensor Independent EW Functionality Interface
N03-111	Laser Beamrider Optical Countermeasures

N03-112 Modeling and Simulation of Cultural Differences in Human Decision-Making

N03-113 Zinc Oxide Based Photonics Devices

N03-114 Tools for Simulating Terrain Data

N03-115 Multifunction, High Resolution, High Frame Rate Infrared Sensor

N03-116 Four dimensional (4-D) Atmospheric Instrumentation

N03-117 Tactical Anti-Submarine Warfare (ASW) Environmental Sensing

N03-118 Scene Model For Low Observable Infrared Surface Combatants

N03-119 Hybrid electric drive for small craft

N03-120 New Low Cost Resins Systems

N03-121 Sensors for condition monitoring of hydraulic fluids

N03-122 Non-Intrusive Pressure Measurement System

N03-123 Non-toxic / non-leaching antifouling coating

N03-124 Ship Hull Design and Performance

N03-125 Real-time Distributed Detection of Damage to Shipboard Fluid Networks

N03-126 Technology for Sensing Contaminants from Submarines

N03-127 Synthetic Androstene Derivatives and Natural Androstene Metabolites in Trauma

N03-128 Neurologic and Cognitive Outcome after Resuscitation of Casualties with Whole Blood-like Blood Substitutes

N03-129 Human Activity Recognition

N03-130 Human Error Modeling

N03-131 Advanced Helmet Systems Umbilical Interface

N03-132 Pilot Behavioral Modeling for Flight Operations Near Ships

N03-133 Water Tight Surface Geometry From IGES, CAD and STEP Files

N03-134 UAV Metric Sensor Suite

N03-135 Advanced Across-Sensor Geospatial Applications To Support Battlefield Preparation

N03-136 Individual Combatant (IC) Weapon Firing Algorithm for a Military Operations in Urban Terrain (MOUT) Environment

N03-137 Aluminum-Air Fuel Cell/Battery Research

N03-138 Unmanned Aerial Vehicle for Magnetic Sensing

N03-139	Over-the-Horizon Communications for Small Autonomous Ground Based Observations
N03-140	Smart Power Systems for Small, Long Term Autonomous Ground based observations
N03-141	Precision Air Delivery (PAD) Carrier for Expendable Ground-based Sensors
N03-142	Bandwidth Management System
N03-143	High Frequency (HF) Radio Automated Link Establishment (ALE)
N03-144	Broadband Antenna and Radio Frequency (RF) Distribution Technologies
N03-145	Adaptive TDM (Time Division Multiplexing) Resource Manager
N03-146	Robust Towed Array Beamforming
N03-147	Multi-Band Antenna For L, S, and X-Band Data
N03-148	Development of Advanced Shape Memory Alloy Materials and Applications
N03-149	Trusted Application layer interface to Trusted Operating Systems
N03-150	Multi-Intelligence SIGINT (COMINT/ELINT) Sensor Processing
N03-151	Intelligent Mission Management and Tasking for the Expeditionary Sensor Grid (ESG)
N03-152	Undersea (ISR) Intelligence Surveillance Reconnaissance Data Fusion Processing
N03-153	Low Cost Alternatives To Expensive Complex Manifold Pipe Shapes Used In High Temperature (3000F-4500F) Missile Control Systems.
N03-154	In-Situ Propellant Monitoring System
N03-155	Low-cost Multi-sensors as Embedded Gauges for In-situ Non-Destructive Evaluation (NDE) of Rocket Motor Serviceability

Navy 03.1 Keyword Index

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Navy 03.1 Topic Descriptions

N03-001 TITLE: Field Chemical Analysis Tool

TECHNOLOGY AREAS: Chemical/Bio Defense, Materials/Processes

ACQUISITION PROGRAM: Nuclear Biological Chemical Program

OBJECTIVE: Develop a small, lightweight, chemical analysis instrument capable of rapidly analyzing sorbed chemical samples.

DESCRIPTION: A key deficiency of Chemical Defense and Preventive Medicine capabilities (as identified in the JFOC) is the inability to analyze complex chemical samples in a field environment without the benefit of a mobile laboratory. The FCAT SBIR will develop and integrate a small, lightweight, low thermal mass "flash" gas chromatograph (GC) with a rapid chemical discriminator such as an Ion Mobility Spectrometer (IMS) or Mass Spectrometer (MS). The FCAT will have a sample introduction port compatible with Solid Phase Micro Extraction (SPME) techniques. Flash GC and SPME are emerging technologies that, if integrated, would provide an immediate impact to America's war on terrorism. Such a system would out perform current field detectors in both speed and selectivity. System weight would not exceed 35 lbs. and analysis run time would be approximately 90 seconds. System design would emphasize field maintainability.

Such a capability would allow the:

- U.S. Customs service to rapidly screen 1000's of containers for illicit substances whether they were drugs of abuse or chemical warfare agents.
- Preventive Medicine Technicians to identify hazardous toxic industrial compounds during deployments and Operations Other Than War.
- Special Forces to perform onsite confirmatory analysis
- Domestic first responders to identify the presence of chemical warfare agents in the presence of interferents.

PHASE I: Develop a brass board proof of concept to demonstrate key interfaces and overall system performance.

PHASE II: Construct prototype systems suitable for testing the limits of detection and field ruggedness. Conduct testing using chemical warfare agent simulants and common interferents.

PHASE III: Transition to the Family of Incident Response Systems (MC only) and the Joint Modular Chemical and Biological Detection System (SOCOM). Commercial application to the Domestic Preparedness and Infrastructure Protection effects would be immediate.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The private sector application will be sales to the domestic preparedness market (i.e. Department of Justice, State and local fire, police, EMS, hospitals) and the industrial hygiene market (i.e. sick building monitoring).

REFERENCES:

1. Thomas E. McKone, et al, Strategies to Protect the Health of Deployed U.S. Forces National Academy of Sciences Institute of Medicine, 2000,p. 99-105.

2. Laboratory Study of Diffusive Sampling/Thermal Desorption/Mass Spectroscopy. OSHA Salt Lake Technical Center, April 2002

3. Hans-Ake Lakso, Determination of Chemical Warfare Agents in Natural Water Samples by Solid-Phase Microextraction, Anal.Chem. 1997, 69, 1866-1872

KEYWORDS: Chemical Warfare Agent Screening; Detection; Sampling; Analysis

N03-002 TITLE: Extending the Life of Biosensors with Dendrimers

TECHNOLOGY AREAS: Chemical/Bio Defense, Materials/Processes

ACQUISITION PROGRAM: ACAT IV

OBJECTIVE: Extend the operational and storage lifetime of real-time non-immunoassay based biosensors.

DESCRIPTION: Sensor systems being developed for continuous monitoring of biological agents in the field, at military installations, or government facilities necessitates sensors that are robust with long operational lifetime. Biosensors are being developed for detection of Biological Warfare Agents (BWA) that utilize molecular recognition and fluorescent reporter molecules [1-3]. The sensors detect organisms and biological toxins by class, so that the exact nature of the agent does not need to be known in advance. This approach is particularly valuable given the threat from unanticipated or genetically modified organisms. Another advantage is that the sensors detect airborne material directly, eliminating the need for an aqueous sample and reagent addition. Methods are needed to improve the operational and storage lifetime of these sensors. Dendrimers are highly branched polymers that are being studied for a variety of applications in chemistry and biology [4]. There is some evidence that incorporation of materials such as dendrimers into sensing films will improve sensor storage lifetime [5].

PHASE I: In Phase I long lifetime (> 24 hour) biosensor materials will be demonstrated under limited conditions. Laboratory experiments will be conducted to study the incorporation of various dendrimer materials into generic biosensors. Dendrimers of different size and bearing different functional groups will be tested. The sensors will be characterized for sensitivity, response time, stability and operational lifetime. Initial studies will be conducted to show the potential for improved storage lifetime using the dendrimer additives.

PHASE II: In Phase II Biosensors with dendrimer additives will be more fully characterized in the laboratory and the field. A long term and more rigorous plan for operational and storage lifetime will be developed and implemented. The effects of temperature and humidity, and cycling of these parameters, on operational lifetime will be measured. Sensors will be tested in representative packaging and shelf life studies will be conducted. Temperature and humidity effects on storage lifetime will be measured. A prototype biosensor system for autonomous, continuous operation will be fabricated and demonstrated in the Phase II effort. The system will be configured as a handheld or small point detector. The operational lifetime of the sensors under ambient conditions will be determined. Algorithms based on current and past environmental parameters and signal levels will be developed to provide an alert for sensor change out.

PHASE III DUAL USE APPLICATIONS: Generic sensors that rapidly detect biological materials and toxins can be used for early warning, homeland security applications, and by first responders. Sensors with enhanced lifetime and storage could also be place in HVAC systems to monitor municipal buildings, hospitals and operating rooms, nursing homes and food processing facilities to help ensure against introduction of potentially pathogenic organisms.

REFERENCES:

1. Iqbal, S.S., Mayo, M.W., Bruno, J.G., Bronk, B.V., Batt, C.A., and Chambers, J.P., "A review of molecular recognition technologies for detection of biological threat agents", Biosensors and Bioelectronics, 15, 549-578 (2000).

2. Chuang, H, Chang, A.C., Taylor, L.C., and Tabacco, M.B., "Semi-selective Optical Sensors for Real-Time Detection of Biological Warfare Agents", First Joint Conference on Point Detection for Chemical and Biological Defense, Williamsburg, VA, 23-27 October 2000.

3. "A healthy glow - or perhaps not", Biophotonics International, 8, 19 (May 2001).

4. Freemantle, M., "Blossoming of Dendrimers", C&E News, 77, 27-35 (1999).

5. Chang, A.C., Gillespie, J.B., Tabacco, M.B., "Enhanced Detection of Live Bacteria Using a Dendrimer Thin Film in an Optical Biosensor", Anal. Chem., 73, 467-470, (2001).

KEYWORDS: biosensors, biological warfare agents, optical sensing, dendrimers

N03-003 TITLE: Single Component, Zero Volatile Organic Compound, Chemical Agent Resistant Coating

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: MARCORSYSCOM CSLE, ACAT level IV

OBJECTIVE: Develop a single component chemical agent resistant coating (CARC) topcoat which has the performance suitable for U.S. Marine Corps (USMC) land based equipment as a drop-in replacement for the current exterior topcoats while being void of volatile organic compounds (VOCs).

DESCRIPTION: Current USMC CARC topcoats are required to protect the substrate from the harsh natural/service-imposed operational environment, minimize enemy threat detection, and resist contamination/degradation by chemical agents. Also, paint application in the field is generally limited to brushing, rolling, and spraying (air-atomizing, air-assisted airless, high volume low pressure) at ambient temperature and humidity. High performance topcoats for these applications have historically been based on two component solvent-based urethane topcoats and more recently on single component solvent-borne and dual component water-dispersible urethane topcoats which achieve full-cure properties at room temperature within 7 days. These types of paints currently have VOC levels of 210 - 420 g/l. Although these topcoat technologies produce materials of satisfactory performance, component mixing and concentration errors have occurred in the field with multi-component paints with less than acceptable results. A zero VOC, single component, high performance topcoat is a long term solution which will produce a significant beneficial influence to USMC PM's, equipment manufacturers, and maintenance organizations at all levels (i.e., depot, intermediate, and organizational).

PHASE I: Provide resin synthesis feasibility study and a preliminary pigment compatibility feasibility study which demonstrates the appropriate mechanical, chemical, and theological properties such that the objectives are obtainable in the subsequently developed finished paint formulations (i.e., Phase II). This material shall be compatible with brush and conventional air-atomized spray application methods. While full cured performance of the final paint formulation must be obtained at ambient room temperature conditions within 7 days, cure kinetics which hasten this process without sacrificing long term performance is desirable.

PHASE II: Develop a paint formulation with application and film performance properties that satisfy or exceed the most stringent performance requirements of standard exterior paint specifications used by the U.S. Marine Corps (i.e., MIL-C-46168, MIL-C-53039, and MIL-DTL-64159) in the primary camouflage color: Green 383 (FED-STD-595 Color#34094).

PHASE III: Produce a pilot plant batch of the optimum formulation, demonstrate/validate application properties on operational vehicles/support equipment at a USMC maintenance depot, and confirm long term durability (12 and 24 months) on operational/in-service field equipment as a drop-in replacement for the current topcoat.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Special operations detachments of local and federal law enforcement agencies and emergency rescue detachments of city fire departments could be potential users of this technology. In general, this technology can be utilized by the architectural, industrial maintenance, and transportation industries for the painting of equipment requiring high chemical and weathering resistance, particularly where ambient curing and the use of standard application equipment is desired.

REFERENCES:

1. MIL-C-46168, Coating, Aliphatic Polyurethane, Chemical Agent Resistant

2. MIL-C-53039, Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant

3. MIL-DTL-64159, Coating, Water-Dispersible Aliphatic Polyurethane, Chemical Agent Resistant

KEYWORDS: Resin, Pigment, Topcoat, Volatile Organic Compound, Chemical Agent Resistance

N03-004 TITLE: Lightweight, inexpensive, corrosion inhibiting integral and/or multi-component ElectroMagnetic Interference (EMI) and environmental seals for Advanced Amphibious Assault Vehicle (AAAV)

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: DRPM AAA, ACAT ID

OBJECTIVE: To design and develop a compact one-piece integral and/or multi-component seal design for air and water tight sealing, corrosion prevention/minimization, and EMI protection on the vehicle.

DESCRIPTION: In order to be lightweight, the AAAV hull is a space frame structure with separate mountable armor modules. The egress/ingress of the 3 vehicle operators and the 17 embarked Marines requires the provision of hatches and doors. Additionally, the vehicle contains numerous bolted access panels to permit maintenance and to maintain necessary compartment separation among different vehicle areas. Due to the AAAV's harsh marine operating environment, very efficient sealing at the above noted openings and possibly other orifices (thru-hull penetrations of any kind) are required for ruggedness and durability, for EMI continuity and as a corrosion inhibitor.

The egress/ingress area seals must be designed to account for multiple users, extensive repetitive use and any required human factors characteristics. Additionally, bolted access panel seals must be designed to retain their characteristics knowing there will be frequent removal/reinstallation of the panels.

The electronic warfare and communication environment of the AAAV requires an efficient, continuous EMI protection at all points on the vehicle. The vehicle openings must be provided with EMI protection around the periphery for shielding effectiveness. The need for an EMI seal shall not in anyway compromise the efficiency or use of the environmental seal.

Corrosion is a predominant characteristic in the marine environment and the seals shall be designed to limit/minimize corrosion on the parent vehicle made of 2519 aluminum. In case of multi-component seals, the void volume in between seals must not entrap any water that would enhance corrosion. Because of the operating environment, all seals are subject to salt contamination. Regular cleaning subjects them to high-pressure water and/or steam plus some commercial of the self (COTS) chemicals. The sealing must endure the inherent operational condition of the vehicle like racking, vibration, and occasional foot traffic. The corrosion shall be limited to the cheap and easily replaceable component in the sealing matrix.

PHASE I: Develop and provide a design concept(s) of an innovative integral and/or multi-component sealing to address both the leakage and EMI protection around the various openings. This will address the compatible materials for both purposes and precise seating definition for the seals. The compression and/or attachment force requirements on the seals must be precisely defined. This is a function of seal material and geometrical configuration of the seal. The compression makes the seal achieve its intended function. In cases of hatches, operator capability, comfort and ease of operation may limit the force to accomplish the required compression. DRPM AAA will provide the hatch operation forces. In other instances, the contractor shall provide tightening torque or other attachment forces for this purpose. For the access panels and ingress/egress areas, frequent use necessitates the precise definition of operative forces to ensure continuation of sealing/EMI protection after use. The design concept shall meet all the operational and functional requirements of the AAAV plus related regulations of Environmental Protection Agency (EPA). EMI material selection shall include corrosion testing methodologies.

PHASE II: The contractor will fabricate prototype seals designed during Phase II of the program. The contractor will perform necessary materials and proof-of-concept testing to optimize material selection and design. The prototypes will be integrated into the AAAV test vehicle and/or bench test bed to test and prove the full range of functionality. The contractor shall work with the AAAV prime contractor vehicle integrator to develop requirements for an easily integratable system. The contractor shall provide required technical assistance and support in preparation for and during these test events. Support will include the development of installation and maintenance procedures as required. DRPM AAA will be responsible for the actual installation and removal of the prototype seals in the AAAV prototypes.

PHASE III: The contractor shall develop a manufacturing plan for fabricating and delivering the seals in support of production and fielding of the AAAV fleet.

Private Sector Commercial Potential: The seals designed can be used in any commercial applications where sealing and/or EMI are prerequisites for the functionality of the system.

REFERENCES:

1. MIL-STD-1605. Procedures for conducting a shipboard electromagnetic interference (EMI) survey (surface ships).

2. MIL-STD-1310. Shipboard bonding, grounding and other techniques for electromagnetic compatibility and safety.

3. MIL-STD-461D Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility.

4. MIL-STD-462D Electromagnetic Interference Characteristics, Measurement of.

5. MIL-STD-464 Electromagnetic Environmental Effects Requirements for Systems.

KEYWORDS: EMI, Corrosion, Seal, Hatch, Armor, Void Volume, Sea Water, Salt, Environment

N03-005 TITLE: Polymer-Cased Ammunition for Small Arms and Cannon Ammunition

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IV MARCORSYSCOM-AM

OBJECTIVE: To identify an optimal polymer material and develop the manufacturing process that will result in a lightweight all-polymer cartridge case with the intent of applying the technology to infantry small arms and cannon ammunition. The primary ammunition of interest is the 0.50 Caliber BMG for use in the Browning M2HB machine gun, M3 machine gun, and Barrett M82A3 anti-materiel rifle. Secondary ammunition of interest include both the 7.62 X 51 mm (M60 and M240 machine guns) and 5.56 X 45 mm (M16,M4, M40 and M249 weapons).

DESCRIPTION: Advances in weapon systems have resulted in Marines carrying additional gear and land and air vehicles being equipped with high tech guidance, targeting, and fire control systems to enhance combat effectiveness, but at the cost of increased weight. Improvements in polymer technology and manufacturing processes that would allow the use of lightweight polymers as a cartridge case material would alleviate a portion of this weight burden. Polymer materials have the potential of being 5 to 7 times lighter than steel and brass and half the weight of aluminum. A secondary benefit of polymer cartridge ammunition is the reduction of strategic metals for cartridge cases during wartime production. Research and development is necessary to determine if polymer cartridges are capable of functioning reliably in existing weapons designed for metallic cartridges and safely containing the pressures and temperatures produced by the interior ballistic cycle. The polymer cartridge must also be capable of surviving the physical and natural environments in which it will be exposed during the ammunitions intended life cycle along with meeting or exceeding the reliability and performance of existing fielded ammunition.

PHASE I: Investigate polymer materials that exhibit the necessary material properties to function in an ammunition environment and are compatible with ammunition components, i.e. propellants, primers, projectiles, sealants, etc.

Research and develop an optimal cartridge design and manufacturing process to ensure the polymer cartridge will function reliably and safely in existing weapons. Develop modeling and simulation capabilities to ensure that the polymer cartridge design has the necessary physical, mechanical, thermal, and structural properties to perform the function of a cartridge case.

PHASE II: Fabricate polymer cartridges to demonstrate safety, reliability, and performance in the intended weapons for use. Conduct lifecycle, environmental, and safety testing to ensure the polymer cartridge can survive the storage, transportation, and operational environments encountered by ammunition.

PHASE III: Demonstrate producibility of the polymer cartridge technology and develop a fielding plan for the alternative ammunition for the Marine Corps.

COMMERCIAL POTENTIAL: Polymer cartridge technology can be directly applied to the commercial small arms ammunition industry. Polymer cartridge ammunition has the potential to be a low cost alternative to brass ammunition for domestic commercial sales and foreign commercial and military sales.

REFERENCES: Rinker, R.A., "Understanding Firearm Ballistics", Mulberry House Publishing, 2000.

KEYWORDS: ammunition, polymer, lightweight, cartridge, case, plastic

N03-006 TITLE: Single Component, Zero Volatile Organic Compound, Chemical Agent Resistant Primer

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: MARCORSYSCOM CSLE, ACAT level IV

OBJECTIVE: Develop a single component, zero volatile organic compounds (VOC's), chemical agent resistant primer which has the performance suitable for the exterior surfaces of U.S. Marine Corps (USMC) land and amphibious equipment. The finished product shall in every aspect be the same or less intrusive to the environment than the current USMC primers.

DESCRIPTION: Current primers used on USMC land and amphibious vehicles are the primary layer of protection from the harsh natural/service-imposed operational environment. These primers are expected to protect pretreated steel and Al as well as organic matrix composites as processed at the original equipment manufacturer and are expected to protect non-pretreated, blasted (~1.5 mil profile) steel and Al as processed at field maintenance activities (i.e., depot, intermediate, and organizational). These primers, individually and as part of the chemical agent resistant coating (CARC) system, must resist contamination/degradation by chemical agents as defined in MIL-C-46168. Good coating cohesive strength and good adhesion at the substrate/primer and primer/topcoat interfaces are essential since both the primer and the topcoat afford specific and essential functionality to the overall performance of state-of-the-art CARC systems. Paint application in the field is performed via brushing, rolling, and spraying at ambient temperature and humidity. High performance primers for these applications have historically been based on two component solvent-based epoxy and more recently on two component water-borne epoxy resin technology which both achieve full-cure properties at room temperature within 7 days. These types of paints currently have VOC levels of 340-420 g/l. Although these primer technologies produce materials of satisfactory performance, component mixing and concentration errors have occurred in the field with multi-component paints with less than acceptable results. A zero VOC, single component, high performance primer is a long term solution which will produce a significant beneficial impact to USMC PM's, equipment manufacturers, and field maintenance activities.

PHASE I: Provide resin synthesis feasibility study which demonstrates the appropriate mechanical, chemical, and rheological properties such that the objectives are obtainable in the subsequently developed finished paint formulations (i.e., Phase II). A pigment compatibility study shall also be performed if the finished primer formulation is envisioned to contain a pigment system. This material shall be satisfactorily applicable with brush and conventional air-atomized spray application methods. While full cured performance of the final paint formulation must be obtained at ambient room temperature conditions within 7 days, cure kinetics which hasten this process without sacrificing long term performance is desirable.

PHASE II: Develop a paint formulation with application and film performance properties that satisfy or exceed the performance requirements of standard exterior primer specifications (i.e., MIL-P-53022 and MIL-P-53030) used by the U.S. Marine Corps. In addition to these requirements, satisfactory adhesion and corrosion resistance (per MIL-P-53022 and MIL-P-53030) at a primer dry film thickness of about 2.0 mils on blasted (~1.5 mil profile) steel and Al substrates shall be demonstrated both with and without a standard topcoat (i.e., MIL-DTL-64159, MIL-C-53039, or MIL-C-46168). Also, adhesion per ASTM 4541 shall be demonstrated to be comparable to the performance of MIL-P-53022 primer at a dry film thickness of about 2.0 mils on blasted steel and Al substrates both with and without a standard topcoat. And finally, corrosion resistance per GM9540P shall be demonstrated to be comparable to the performance of a MIL-P-53022 primer at a dry film thickness of about 2.0 mils both with and without a standard topcoat on blasted steel (up to 80 corrosion cycles) and blasted Al (up to 120 corrosion cycles).

PHASE III: Produce a pilot plant batch of the optimum formulation, demonstrate/validate application properties on operational vehicles/support equipment at a USMC maintenance depot, and confirm long term durability (12 and 24 months) on operational/in-service field equipment as a drop-in replacement for the current primers.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be utilized by the architectural, industrial maintenance, and transportation industries for the painting of surfaces requiring high corrosion and chemical resistance, particularly where ambient curing and the use of standard application equipment is desired.

REFERENCES:

1. MIL-P-53022: Primer, Epoxy Coating, Corrosion Inhibiting, Lead and Chromate Free

2. MIL-P-53030, Primer Coating, Epoxy, Water Reducible, Lead and Chromate Free

3. MIL-C-46168, Coating, Aliphatic Polyurethane, Chemical Agent Resistant

4. MIL-C-53039, Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant

5. MIL-DTL-64159, Coating, Water-Dispersible Aliphatic Polyurethane, Chemical Agent Resistant

6. ASTM D 4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

7. GM9540P, General Motors Engineering Standards, Accelerated Corrosion Test

KEYWORDS: Resin, Pigment, Primer, Volatile Organic Compounds, Chemical Agent Resistance

N03-007 TITLE: Improved Propeller De-Icing Systems

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT II: PMA-231: C-2/E-2 Program

OBJECTIVE: Develop advanced electrical current collection and transfer technology to improve the propeller de-icing system for E-2C, C-2, P-3 and C-130 aircraft.

DESCRIPTION: The current de-icing system requires extensive maintenance, including solvent degreasing and component replacement, every 250 engine operating hours. The system is adversely affected by the inevitable leakage of hydraulic fluid in the hub area, causing sporadic electrical conduction, and significantly reduced de-icing performance. Testing the propeller blade and hub de-icing system is a safety of flight check, done prior to every takeoff. If the system is down, the aircraft is down, should icing conditions be anticipated. Maintaining the system is a significant sailor and depot maintenance burden that could be greatly reduced or eliminated through the application of advanced technology. The approach may be one, or a combination of technologies. The approach should consider keeping weight, complexity, and power requirements to a minimum. There have been significant technology improvements in recent years with innovative approaches to transferring electrical current across rotating collector elements that would offer significantly decreased sailor and depot maintenance and improved operational availability, while increasing the operational availability of the de-icing system and the aircraft. The goal is to implement this improved technology in three years or less. The E-2C propeller brush block assembly is composed of a composite housing with electrical contact connectors and carbon brushes. The brushes can be replaced on the connectors by soldering. The connector and brushes with a guide and spring are fitted into the composite housing and a plate is screwed on the back of the housing to hold all in place. The assembly is then bolted to the propeller pump housing assembly. The pump housing assembly goes on the prop shaft first then the propeller. On the back of the propeller is the electrical contact ring. The carbon brushes ride on the electrical contact ring as the propeller spins.

PHASE I: Develop a design concept and establish technical merit of proposed technology. The proposed design concept should minimize weight, complexity and power requirements while maximizing the propeller de-icing capability.

PHASE II: Finalize the design and fabricate a functional prototype that may be demonstrated on selected propeller driven aircraft. Evaluate prototype de-icing capability.

PHASE III: Improve functional prototype demonstrated in Phase II, to a reliable and maintainable airworthy system. Ensure the technology developed during Phase II can be effectively produced and incorporated efficiently into propeller driven aircraft, and/or helicopters.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Aircraft manufacturers of both civilian and military aircraft could incorporate this technology to provide more reliable and effective propeller and/or rotor blade de-icing. Commercial airlines flying propeller driven aircraft as well as helicopter operators could incorporate this technology to reduce costs and improve safety.

REFERENCES:
1. Electrical Contacts, Principles and Applications. Edited by Paul G. Slade. New York, NY: Marcel-Dekker, Inc., 1999.
2. Pictures from and E-2C aircraft engineering investigation are available on SITIS at http://dtica.dtic.mil/sbir/

KEYWORDS: De-Icing; Electrical; Safety; Electro-Magnetic Interference; Propeller; Rotor

N03-008 TITLE: <u>Passive Rocket Motor Identification</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-272: Advanced Tactical Aircraft Protection Program

OBJECTIVE: Develop and test innovative processing techniques and identify unique rocket motor and explosive initiated projectile observables and sensor technology that will allow the reliable identification and location of a projectile launch and using passive sensors in real time.

DESCRIPTION: Military and commercial aircraft are vulnerable to attack from a wide variety of guided and unguided rocket propelled and explosive projectile threats. The guided threats include but are not limited to radar guided and heat seeking surface-to-air and air-to-air missiles and laser beamrider missiles. Sensor technology (i.e., sensitivity) has progressed sufficiently that imaging missile warning systems are being considered for development for U.S. aircraft to aid in situational awareness and as part of a defensive suite. The ability to correctly identify the propulsion system would classify the missile type and improve the effectiveness of any countermeasure or tactic used against the threat and (via geolocation) enhance the situational awareness of the battlespace. Advances in sensor and processing technologies broaden the range of threat characteristics and processing algorithms that can be used to solve the passive identification problem. As an example, large arrays operating in the infrared (IR) and visual bands are available that were prohibitively expensive in the past. When combined with currently available processing power, these arrays may be able to observe a greater range of motor characteristics that can be used as inputs to powerful identification techniques, such as fuzzy logic, optical/temporal flow, pattern matching, neural nets, etc. A variety of explosive characteristics and observables would support the use of powerful identification techniques. They include narrow band spectral fluorescence, spatial characterization, broad band/narrow ratio, passive velocity estimation, temperature fluctuations, and plume size changes are just a few.

PHASE I: Investigate which characteristics are providing signals that can be exploited with new technology sensors and identification algorithms. Conduct analysis of variance studies to identify the predominant rocket motor and explosive projectile characteristics available for sensing systems. Develop a conceptual design of a sensor and processing system to verify these identification techniques.

PHASE II: Develop a detailed design for a sensor and processing system that exploits the characteristics identified in Phase I and build a prototype. Demonstrate in laboratory testing the ability of the techniques and prototype to identify and locate a missile launch and other explosive initiated projectiles

PHASE III: Techniques and prototype will be transitioned to airborne missile warning efforts under PMA-272 and the Joint Strike Fighter (JSF).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The application of recent advances in sensors and processors should allow the identification system to be very cost effective. For various commercial applications, a cost-effective system will have application to platforms that heretofore have not warranted a threat identification system (i.e., commercial airlines). In addition, with the increased connectivity between DoD platforms and more widespread installation of threat identification systems, a dramatic increase in situational awareness will be available.

KEYWORDS: Rocket Motors; Passive Identification; Passive Sensors; Identification Algorithms; Situational Awareness; Guided Threats

N03-009 TITLE: Ultrapure, Spherical, Monodisperse, Unagglomerated Nanopowders for Infrared Window Materials

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

ACQUISITION PROGRAM: PMA-265: F/A-18 Strike Fighter Program, PMA-272: Advanced Tactical Aircraft

OBJECTIVE: Develop and produce nanopowders of oxides and/or fluorides that are suitable for pressing into transparent ceramic windows that will retain nanometer grain size.

DESCRIPTION: Windows for infrared sensors on missiles and aircraft must be of high optical quality and must be durable enough to protect the delicate sensor from harsh environmental conditions. Mechanical and thermal shock capabilities of windows are limited by their mechanical strength, which, in turn is related to the grain size in these polycrystalline materials. Over some range of grain size, decreasing the grain size of a polycrystalline ceramic increases its mechanical strength. Thermal shock resistance, rain impact resistance, and projectile impact resistance all increase in proportion to mechanical strength. By contrast, the optical quality of polycrystalline ceramics tends to decrease with decreasing grain size because of impurities and second phases concentrated at grain boundaries. Pure materials with very clean grain boundaries are likely to be required for good optical quality in nano-grain materials. Composite compositions normally produce too much optical scatter to be used as optical materials. If the grain size is sufficiently smaller than the wavelength of light to be transmitted, composite optical materials with unprecedented mechanical properties might be possible. Unagglomerated, spherical, monodisperse powders should facilitate the fabrication of fully dense windows.

The Government has an Exploratory Development program in progress to attempt to make polycrystalline nano-grain ceramic window materials. Commercial sources of ultrapure, spherical, monodisperse, unagglomerated nanopowders are lacking. The goals of this program are as follows: (1) Demonstrate a process for producing unagglomerated, monodisperse spherical particles with diameters less than 25 nm. Candidate materials include yttria, magnesia, zirconia, aluminum oxynitride (ALON), spinel, magnesium fluoride, strontium fluoride, yttrium fluoride, and lanthanum fluoride. The target for monodispersity is a standard deviation in diameter of 10-percent;

(2) Demonstrate that the process can be scaled up to a 1-kilogram quantity and show that it is plausible for the process to be scaled up to 10- to100-kilogram quantities; (3) Demonstrate ultra-clean techniques that can be used with high purity starting materials (at least “5 nines” purity) to produce high purity powders; (4) Measure the major impurities in the powder by spark source mass spectrometry and/or inductively coupled plasma analysis with atomic emission or mass spectrometry. Compare the impurity levels in the spherical powder to those in the starting material from which the powder was made.

PHASE I: Demonstrate a process for producing unagglomerated, monodisperse spherical particles of one or more of the candidate materials with diameters less than 25 nm. Measure the particle size distribution. Using ultrapure starting materials, produce at least 100 g of powder to be provided to the Government for processing into a fully dense ceramic. The Government ceramic processing will be provided at no cost to the SBIR contractor. Measure impurity levels in the starting material and in the nanopowder. Provide all supporting analytical data, including electron micrographs.

PHASE II: Optimize the process for powder production and scale up to at least 10 kilograms. Extend the process or explore alternate processes for producing at least two other powders of chemical compounds to be selected by mutual agreement with the Government. Prepare at least 10 kg of each powder. Provide analytical characterization of all powders, including particle size distribution and purity.

PHASE III: Demonstrate commercial production capability for 100-kilogram quantities of selected ultrapure, monodisperse, unagglomerated nanosize powders.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Powders produced from this work could be used as raw material to make bulletproof windows and high-temperature windows for sensors to monitor industrial processes.

REFERENCES: Harris, D. C., Materials for Infrared Windows and Domes. Bellingham, WA: SPIE Press, 1999.

KEYWORDS: Nanopowder; Infrared Window; Ceramics; Ultra Pure Materials; Monodisperse; Unagglomerated

N03-010 TITLE: Innovative and Scalable Near Net-Shape Manufacturing for Shape-Memory Alloy

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA-275: V-22 Program

OBJECTIVE: The primary objective of this work is to develop an innovative and scalable near net-shape manufacturing process for making NiTinol used in the actuator system for naval aircraft applications.

DESCRIPTION: Shape-memory alloys (SMA’s) have emerged as materials with unique thermal and mechanical properties that have potential to be used in many underwater, surface, and airborne naval applications. The use of technologically advanced materials is an important strategic advantage in a combat offensive maneuver. For one example, the effect of the rotor blade on the aerodynamic behaviors of the V-22 Osprey varies in the transition from the hover mode to the cruise mode of flight. It is thought that the shape-memory behavior of an SMA could be used to reconfigure the shape of the blade during flight, thus optimizing flight efficiency for the different regions. Similarly, other fixed- and rotary-wing aircraft platforms may also benefit from incorporating the use of SMA’s for actuation and reconfigurability. It is anticipated that this material technology will have a significant payoff to naval aviation and the Navy.

The U.S. Navy is interested in using NiTinol SMA for actuation in naval aircraft. It is important to control and streamline the process and obtain repeatability. Most of the commercial production processes for NiTinol use a casting process followed by rolling/swaging. Consequently, defects known to be caused by the casting/rolling process are introduced to the material during solidification and subsequent metalworking. Another drawback is the introduction of residual stresses to the final SMA material. Repetitive annealing steps may be required to eliminate this effect. As a result, the SMA microstructure may be quite different and would vary the resultant SMA transformation characteristics. Furthermore, it is difficult and labor-intensive to machine NiTinol to net shape.

The shape-memory behavior needs to be more closely controlled and predictable in order to design the actuation mechanisms more reliably, efficiently, and cost effectively. An alternative affordable manufacturing process is sought that will avoid these defective properties and obtain more accurate and reliable shape-memory materials. Specifically, an innovative and scalable near net-shape manufacturing process for making NiTinol in close and open forms (in tubular form, up to 12 inches in length, 3 inches outside diameter, and 0.25 inch in tube thickness). Careful examination of the proposed manufacturing process, in terms of individual material and process effects, on the shape-memory behaviors of the materials needs to be conducted. Other properties of interest include the thermal and mechanical fatigue under service loading and a corrosive environment.

PHASE I: Provide an initial development effort that demonstrates scientific merit and feasibility of the proposed manufacturing process for making the shape-memory materials. A 1/4 scale prototype NiTinol in tubular and flat forms will be fabricated and characterized thermally and mechanically.

PHASE II: Fabricate and characterize full-scale prototype NiTinol tubular and flat forms based on the Phase I SBIR effort. In this phase, the fabricated full-scale NiTinol specimens in tubular and flat forms will be tested with the Navy-developed thermo-electric heating device. Specific properties of interest include the SMA transformation temperature (TT), induced force at TT, and the thermal-fatigue behaviors under representative service loading and a corrosive environment.

PHASE III: Produce NiTinol for use in actuator systems and transition to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Successful development of an innovative and scalable near net-shape SMA manufacturing process can reduce the acquisition cost of the actuator systems for both commercial aircraft as well as DOD aircraft, and can transition to any other activity needing compact actuation.

REFERENCES: Z.G. Wei et al, "Preparation of a Smart Composite Material with TiNiCu Shape Memory Particulate in an Aluminum Matrix," Materials Letters 32 (1997), pp. 313-317.

KEYWORDS: Shape Memory Alloy; NiTiNOL; Actuator; Thermal and Mechanical Properties; Near Net-Shape Manufacturing Process; Naval Aircraft

N03-011 TITLE: <u>Non-Polymer Optical Fiber Coatings</u>

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

ACQUISITION PROGRAM: PMA-265: F/A-18 Strike Fighter Program, PMA-272: Advanced Tactical Aircraft

OBJECTIVE: Develop a non-polymer coating material and process for optical fibers that will provide extremely high strength, reliability, and environmental durability with small fiber diameter, minimal bend radius, and ease of termination. These high-strength, small diameter fibers have application to fiber-optic aerospace networks, structural health monitoring, high-resolution image transmission, fiber-optic guided weapons, fiber-optic gyros, and optical motherboards for computers.

DESCRIPTION: An optical fiber operates by transmitting light down its glass core, which is made of a doped silica glass material. The cladding, which is around the glass core, is made of undoped silica. The difference in the refractive indices of the core and the cladding confines the light from a light source within the core. Typical optical silica fibers also utilize a polymer or alternative hermetic protective layer over the cladding. The function of this polymer protective coating is to protect the core and the cladding mechanically.

Although it is the best optical material today, silica glass suffers from a number of mechanical disadvantages. These can lead to a finite, sometimes quite short, lifetime of the material if the protective layer is not utilized. The major mechanical disadvantages of the silica material are low fracture toughness (propensity to crack initiation and propagation) and moisture sensitivity. Even a small amount of moisture on the fiber surface can lead to its sudden failure, especially if the fiber is subjected to tension due to tensile or bending deformations.

Because of these shortcomings of the silica material, various polymeric non-silica materials are applied on the surface of the glass fiber to protect it from the harsh environment. Typical coating materials are polymers (non-hermetic coatings) and hard carbon or metals (hermetic coatings). Polymeric materials are characterized by relatively low elastic (Young's) moduli. As a result, polymer coated fibers can withstand relatively high tensile or bending deformations. Polymers, however, absorb moisture; as a result, long-term mechanical reliability of polymer-coated fibers might be not as high as necessary. As to the hermetic coatings, they can provide high hermeticity, but are characterized by high elastic moduli. For this reason, it is not uncommon that the coating rather than the fiber fails first when the fiber experiences elevated strains. In addition, metallizations of optical silica fibers are prone to corrosion. The use of polymers such as acrylates and polyamide also adds to the time and cost of the fiber termination and/or splicing process. An alternative effective coating material, which would possess the merits of polymers and carbons/metallic hermetic coating, without having the drawbacks of these materials, is highly desirable. The materials and processes selected should improve or retain the optical transmission properties of the optical fiber.

PHASE I: Analyze material and process development for a non-polymer optical fiber coating. Perform feasibility studies, using simplified test samples, on existing 125-micrometer-diameter silica optical fibers. These studies and test samples should demonstrate both the optical and mechanical properties and advantages of the selected coating.

PHASE II: Test the coated optical fiber samples to the existing Telcordia industry standards for reliability and performance. Optimize the coating material and process based upon test results and final qualification testing to meet aerospace requirements.

PHASE III: Demonstrate the capabilities of the materials and fabrication technologies developed under this SBIR to leading and small-size optical fiber manufacturers. Develop partnerships to transition this technology into the marketplace.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Today's photonics telecommunications market is estimated at about $4 billion per year. It is estimated that the telecommunications market in 2005 will have a significant impact on the fiber-to-the-home and fiber-to-the-desk market. Other commercial applications can include automotive, medical imaging, remote source lighting, nuclear plant monitoring, oil well logging, structural aircraft monitoring, and various optical sensing applications.

REFERENCES: Society of Automotive Engineers (SAE) Aerospace Information Resource; AIR-5271 "A Guideline for the Application of High Density Fiber Optic Interconnects to Aerospace Platoforms"; 19 June 2002

KEYWORDS: Optical Fibers; Protective Coatings; Non-Polymer; Hermetic

N03-012 TITLE: Damage Characterization and Remaining Life Assessment of Materials

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA-264: Air Anti-Submarine Systems Program, PMA-271: E-6A/B Program

OBJECTIVE: Develop a reliable nondestructive assessment of damage and remaining life of aircraft materials using nonlinear acoustic techniques.

DESCRIPTION: One of the challenges to ensuring the effectiveness and safety of military equipment is to evaluate correctly the quality and life expectancy of materials used in its construction, such as outer surfaces of aircraft, ships, and submarines and elements of their power engines. There have been significant technological advances in the area of prognostic and health management of the air vehicle and power engines. Further development is needed in the evaluation of material damage and life assessment in aging aircraft. Recent research has shown that the nonlinear acoustic response of materials (i.e., generation of higher harmonics, or of difference-frequency signal upon action of two signals at slightly different frequencies) is much more sensitive to the presence of microcracks and other microdefects than the linear response such as the signal damping or reflections. A damage evaluation model is sought that will establish relationships between the nonlinear acoustic response of material's and the useful life remaining.

PHASE I: Determine feasibility to accurately measure controlled damage accumulaton in the samples using nonlinear acoustic techniques. Establish the correlation between the parameters of nonlinear response and damage accumulation in various airframe materials.

PHASE II: Develop a damage evaluation model that will establish relationships between the level of modulation and the microcrack parameters (density, size, internal stress). Demonstrate the accuracy of the models to predict the useful performance life remaining of the materials.

PHASE III: Develop the instrumentation and damage evaluation model for specific aircraft applications and transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The proposed novel technology can have broad civilian applications in a "field friendly" assessment of structure integrity and remaining life of commercial aircraft, reactor walls, gas turbines, pipelines, etc.

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KEYWORDS: Nonlinear Acoustics; Damage Control; Life Time; Nondestructive Testing; Materials; Theoretical Models

N03-013 TITLE: Optimum Polarimetric Radar Imaging System for Automatic Wake Detection Algorithms

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA-264: Air Anti-Submarine Systems Program

OBJECTIVE: Develop an automated capability to detect wakes in real time, from an airborne reconnaissance platform.

DESCRIPTION: Highly trained Navy operators perform the tedious chore of continuously viewing a surveillance screen to manually detect ships and wakes. New methods are sought that would automate the surveillance and detection of wave breaking events that indicate the presence of submerged threats. This includes developing innovative sensor concepts that integrate the signature definition and its characterization with a physics-based model of submersible/wave motions and submersible geometry-related signatures. The proposed system should include suitable interfaces between the sensors, inertial measuring unit, aircraft, and detection algorithms. Based on the different physical nature of radar back-scattering from underwater moving objects and sea clutter, a multifunctional algorithm for target/sea clutter selection should be considered.

PHASE I: Determine the feasibility of developing an automated tool for the detection of moving submerged objects within sea clutter using the Doppler spectra of a dual polarized radar with high spatial resolution. Demonstrate the difference in angular parameters of scattered signals, particularly for free traveling breaking waves and breaking waves produced by a wake, as well as fine structure of their Doppler spectra.

PHASE II: Develop a prototype non-acoustic antisubmarine warfare prediction tool that is able to function with the minimal interaction with an operator. Demonstrate the capability to define the detection probability and false alarm probability under varying ambient conditions. This demonstration could be carried out from piers and at sea.

PHASE III: Develop an airborne prototype system that minimizes the data management and processing burden in a real-time system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The successful innovative sensor design will provide significant new information regarding the physical sources of ocean surface manifestations. As such, the system will be of utility not only for Navy and Coast Guard operations, but also for fishing vessels, oil explorations, various functions in oceanography, location of oil and gas seeps in the ocean environment, operations in shoal area environments, and for other remote sensing functions that require insights into the sub-surface environment.

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KEYWORDS: Radar; Capillary Waves; Group Velocity; Turbulence; Breaking Waves; Nonlinear Interactions, Detection, Submersed Objects

N03-014 TITLE: Air Antisubmarine Warfare (ASW) Environmental Characterization using Existing Tactical Sensors

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-264; Air Anti-Submarine Systems Program, PMA-299: Multi-Mission Helicop

OBJECTIVE: Use innovative sensor processing to enable concurrent acoustic environmental characterization and air ASW search operations with existing Fleet sensors.

DESCRIPTION: New ways are sought to improve air ASW search performance by estimating acoustic environmental parameters (such as transmission loss, bottom loss, ambient noise, etc.) using existing Fleet assets. The concept should utilize sonobuoys in the Navy inventory, operate during search operations, and result in an increased submarine search rate. These real-time acoustic parameter estimates will be used to adapt current search operations (such as ping strategies and processing bands) and aid in making tactical decisions for new search patterns. Frequenceis are between 100 Hz and 2500 Hz. Accurate environmental characterization may also improve shallow water echo classification performance. The estimates should be accurate, local, and current. These techniques would be used to augment existing and planned environmental sensing methods that operate before search operations commence.

PHASE I: Define and evaluate the feasibility of extracting acoustic parameters using existing sonobuoys. Address technical challenges, such as sensor saturation, that may limit existing buoy feasibility. Determine the improvement potential, in air ASW search rates, that can be achieved using 'through-the-sensor' environmental characterization.

PHASE II: Develop a fully working prototype of the required processing techniques. Demonstrate the search rate improvement potential using Government supplied real data. Define and evaluate the trade-offs of through-the-sensor methods to other environmental sensing approaches.

PHASE III: Implement the processing concepts and techniques in Fleet ASW platforms (P-3, SH-60).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The processing methods developed under this project can be used to perform environmental characterization for climate studies, and improved seismic exploration.

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KEYWORDS: Anti-Submarine Warfare (ASW); Environmental Characterization; Acoustic; Sonobuoys; Sensors; Shallow Water

N03-015 TITLE: <u>On-Board Wind Vector and Air Density Sensing for Weapon Applications</u>

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: PMA-201: Conventional Strike Weapons Program

OBJECTIVE: Develop a remote wind sensor/air data system that is lightweight, low-cost, and rugged for weapon applications to measure weapon air data and relative wind.

DESCRIPTION: Many standoff weapons require wind correction for terminal guidance, especially for the release of submunitions. There currently is no affordable weapon mounted ability to determine relative wind at the target area. A weapon mounted, low-cost, compact, reliable, lightweight, and low-power sensor system is needed that will not only accurately measure the weapon air data parameters, such as airspeed, angle-of-attack, and angle-of sideslip, but also remotely determine the wind profile between the weapon and the target. LIDAR (laser radar) and pitot tube technology have been used but the sensor systems have generally been too large and heavy or costly for weapon installation. Proposed concepts should address such issues as radio frequency (RF) signature, reliability, and susceptibility to shock and vibration in an operational environment and provide estimates of production unit size, weight, power, and cost at an annual production rate of 1,000 units. A program production unit cost goal should be $5,000.00 per unit or less.

PHASE I: Develop a concept to measure air data parameters and relative wind. Conduct laboratory feasibility testing to establish the physical and performance parameter goals and production cost of the concept. Provide estimates for production unit cost.

PHASE II: Design and fabricate a prototype system and demonstrate its performance. Perform a preliminary design study for a production unit and preliminary concept for weapon installation. Estimate production unit costs of the proposed design concept.

PHASE III: Integrate the system into weapon systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be made commercially available as a low-cost alternative for current systems used in for general aviation.

KEYWORDS: Wind Vector; Air Density; Sensors; Weapons; Sub-Munitions; Radio Frequency

N03-016 TITLE: Intelligent Test Data Analysis Technology (IT-DAT)

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-282: Cruise Missile Weapons System Program, Joint Strike Fighter (JSF)

OBJECTIVE: Create an innovative method for automated, intelligent and interpretive analysis of software test data for shipboard, submarine and Navy aircraft mission computer systems.

DESCRIPTION: The weapons and aircraft control systems of today are software intensive, very complex, and have many internal and external interfaces and component interrelationships. With incremental development and evolutionary acquisition strategies come frequent software testing of these complex systems. As a result, the analysis and interpretation of software test data is very manpower intensive, error-prone and subject to the expertise of the analyst. In addition, it is difficult to detect unanticipated testing anomalies (e.g, unexpected messages or unusually high memory utilization) and to analyze trends over multiple test cases. This results in high costs and software defects that often escape detection until the systems are fielded. Little automation is available to support such software testing for a complex system, and where it exists, it is simplistic in nature and leaves the interpretation of test data to the analyst. A technology is needed to take system and interface requirements (in natural language), test procedures and recorded test data (e.g., recorded interface messages) and to automatically verify the correctness (timing, message sequences, messages and message values) of the output, make sophisticated, intelligent interpretation of test results, and to look for unanticipated anomalies. To do this, the capability must be adaptive to a variety of input and output formats (e.g., different interface message formats and ranges of value, and the formats of the data extracted), must apply intelligent, interpretative technology to verify test results, detect unanticipated anomalies (even though they may "meet spec"), perform intelligent data trend analysis across multiple test cases, produce summarized and detailed test analysis results, and provide the test analysts with the ability to make complex queries of the test data using a simple and intuitive interface.

PHASE I: Devise an innovative concept for the automated, intelligent and interpretative analysis of software test data. Demonstrate the technical merit of the proposed solution.

PHASE II: Implement and demonstrate an advanced prototype of the technology innovations developed in Phase I. The prototype must be able to support test data analysis of systems that utilize multiple operating systems and a variety of software component interface methodologies (e.g., discrete digital messages, Application Programming Interfaces (API) over socket communications and Common Object Request Broker Architecture (CORBA). The prototype must provide a simple, intuitive user interface for the test analyst. The contractor must demonstrate the potential of the technology to provide manpower and cost savings.

PHASE III: The contractor will mature the technology prototype for use in the testing of software for the Tactical Tomahawk Weapons Control System (TTWCS), and for Navy aircraft mission computer systems on the JSF and F/A-18 aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial potential for this technology is very high. Software is pervasive throughout our society, and all software needs to be tested and verified according to its requirements and interface specifications. Problems detected early result in significant cost savings. Potential applications include but are not limited to: gaming software, web-based software, educational software, and commodities and banking software. In addition, numerous military systems would benefit.

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KEYWORDS: Automated Data Analysis; Artificial Intelligence; Interpretive Data Analysis; Trend Analysis; Software Testing; Software Interfaces

N03-017 TITLE: Automated Generation of Usability Prototypes and Tactical Software

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: ACAT III: PMA-282: Cruise Missile Weapons System Program

OBJECTIVE: Devise an innovative means of automating the process of generating software for usability prototypes and the human computer interface (HCI) software for tactical, distributed, multi-user Navy systems.

DESCRIPTION: A preliminary HCI design must be implemented in a usability prototype for iterative usability testing. The mature HCI design must then be implemented in the software component for a tactical system, usually developed using a mainstream high-level programming language, e.g., C++ or Java. The final software must have an associated, object model of its architecture and also provide software interfaces by which application software components can access the HCI. A variety of specialized commercial tools are typically used to support developers today in developing both rapid usability prototypes and the final tactical software; very little of this process is integrated or automated. The interaction required to support a complex, multiple user and distributed system significantly complicates this process. For example, the usability prototype must allow multiple users to interact with the system and have their interactions affect each other's operations, system status indications, etc.

This SBIR topic seeks to advance the state-of-the-art in HCI software development by automating the software development processes. To do so, an innovative means must be devised and technologies must be applied to: (a) automatically and rapidly generate a usability software prototype from a component-based HCI design, and (b) automatically generate a full-fidelity, reliable HCI software component for tactical systems, along with associated software interfaces (e.g., an application programming interface) and automated extraction of an underlying object model, from the finalized HCI design. These automated capabilities need to support the development of complex, multi-user, distributed systems for commercial computing platforms (e.g., Unix and Windows).

PHASE I: Develop an innovative concept for an automated means of rapidly generating both flexible, adaptive usability prototypes (rapidly reconfigurable) and highly reliable tactical HCI software components, along with the underlying object models and software interfaces that can be accessed by application software components. Demonstrate the technical merit of the proposed solution.

PHASE II: Implement and demonstrate a prototype of the innovative concept developed in Phase I by applying technologies to the problem of automated generation of usability prototypes, the corresponding tactical HCI software components, underlying object models, and software interfaces to the HCI component.

PHASE III: Mature the prototype of this capability for use in the development of software for upgrades to the Tactical Tomahawk Weapon Control System (TTWCS). The contractor will also prepare and sell the product on the commercial market.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial world today uses an iterative usability engineering approach to develop HCI software. The innovation requested in this topic will result in manpower and cost savings. As a result, the commercial potential for this topic is extremely high. In addition, numerous military systems would benefit.

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KEYWORDS: Automated Software Generation; Human Computer Interface; Rapid Prototyping; Usability Testing; Automated Software Design; Object-Oriented Models

N03-018 TITLE: High-Speed Portable Nondestructive Inspection of the Inside Surface of Pipes and Tubing for Corrosion (and Cracks)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC, II: PMA-234: EA-6 Program, PMA-265: F/A-18 Strike Fighter Program

OBJECTIVE: Develop a small hand-held portable system that can rapidly inspect the inside surface of tubing (1.5 inches in diameter and larger with wall thickness 0.060 inches and larger) for pits, corrosion, and cracking with very high definition of small flaws for highly critical components such as the F-18 hook shank and the F-14 Stinger.

DESCRIPTION: The inside surface of tubular shapes larger than 1.5 inches in diameter may be inspected by radiography but small isolated corrosion pits or fine cracks on the order of 0.030 inch in length are very difficult to resolve and the system is hardly portable or inexpensive. Conventional ultrasound systems employing standard focused ultrasonic testing (UT) transducers can detect cracks (0.030 inch and larger) but are relatively insensitive to small rounded pits (such as those on the inside of arresting gear hook shanks), are very slow and expensive, and not very portable. The system envisioned is a small hand-held unit with a heads-up display suitable for use both by Fleet personnel and by private industry in production environments. The unit would be held against the curved surface of piping/tubing and swept back and forth to examine the inside surface at a rate of (up to) several square inches per second with the operator seeing an image much like a visual image or real-time X-ray image. The unit must be capable of detecting small corrosion pits on the order of 0.030 inch in diameter and cracks 0.030 inch in length on the inside surface, outside surface, and interior of the wall area of the piping and tubing.

PHASE I: Develop a conceptual design and construct a laboratory demonstration for proof of principle. The work should include a means of demonstrating the ability to detect the flaws indicated in piping.

PHASE II: Construct and evaluate a field portable prototype system. Naval Aviation Systems Team (NAVAIR) representatives will work closely with the small business in the evaluation of the proposed technology in order to aid in the transition of this technology to commercial applications at no cost to the small business. Testing of real corrosion samples will be used to refine testing parameters. System design should be optimized for portability. The system design should also be optimized to inspect a wide range of pipe diameters. Design and construct a field portable system.

PHASE III: Finalize the design in response to the evaluation results in Phase II and produce a system for transitioning to field use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Inspection of piping in chemical plants and power plants for corrosion is a billion dollar problem, which would also be addressed by this research. Portability of the system is required for Fleet use and also in industry to inspect the maze of piping.

KEYWORDS: Scanning; Composite; Testing; Corrosion; Nondestructive Inspection; Metals

N03-019 TITLE: Real-Time Inspection of Fasteners in Aerospace Structures

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT II: PMA-271: E-6A/B Program, PMA-290: Maritime Patrol Aircraft Program

OBJECTIVE: Develop a small hand-held portable system to inspect rapidly under fastener heads for corrosion and cracks. The fasteners are often ferrous, countersunk, and obscuring the area around the shank of the fastener. Corner cracks 0.030 inches should be detected as well as corrosion. Inspections should be accomplished in less than a minute per fastener.

DESCRIPTION: The complex problem of detecting small discontinuities such as 0.030-inch corner cracks underneath obscuring components such as fastener heads has been accomplished using conventional ultrasound techniques but is difficult, slow, and expensive. Current inspection systems utilize traditional ultrasonic testing (UT) transducers to generate (map) the area under fastener heads by slowly rotating a UT beam (focused to a pencil point) around the fastener head. This system is effective but very slow (minutes per fastener) and gantry mounted. The system envisioned is a small hand-held unit with a heads-up display or small liquid crystal display for full portability able to examine a fastener in less than 30 to 45 seconds. The unit should be able to detect corner cracks 0.030 inches by 0.030 inches in size and larger. The search unit would be held against the surface and possibly rotated around a fastener to examine the surface of the shaft of the fastener under the fastener head with the operator seeing an image very like a visual image or real-time X-ray image. The unit should be shoulder carried.

PHASE I: Develop a conceptual design and construct a laboratory demonstration for proof of principle and confirmation of modeling parameters. The work should include modeling, scanning head proof of concept, and mechanical design and construction of the scanning head. Feasibility of the unit should be established by laboratory inspection of components with known flaws.

PHASE II: Refine the testing head designed in Phase I. Construct and evaluate a field portable prototype system. Naval Aviation Systems Team (NAVAIR) representatives will work closely with the small business in the evaluation of the proposed technology in order to aid in the transition of this technology to commercial applications at no cost to the small business. Conduct testing of actual samples with cracks and/or corrosion to refine testing parameters. System design should be optimized for portability.

PHASE III: Finalize the design in response to the results of the evaluations in Phase II and produce a system for transitioning to field use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is significant commercial potential in the aerospace industry for a tool such as this to non-destructively evaluate aircraft structures for cracks under fasteners. This project will provide a tool, which will reduce the inspection time and cost of common aerospace components. Current inspection procedures are very high dollar value.

REFERENCES: NAVAIR 01-1A-8, Structural Hardware Manual, 1 Oct 1999.

KEYWORDS: Ultrasound; Scanning; Composite; Testing; Corrosion; Nondestructive Inspection

N03-020 TITLE: Novel Main Transmission Design Concepts

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT IC PMA-261: H-53/Executive Transport Helicopters Program, PMA-275:V-22

OBJECTIVE: Investigate alternative main transmission design concepts for rotary-wing aircraft in order to increase power density, reliability, durability, and maintainability.

DESCRIPTION: The primary function of a helicopter main transmission is to take the power from the engine(s), reduce the number of revolutions per minute (rpm) (thereby increasing torque), and transfer it to the rotor system. This is usually done through several stages of reduction gearing within the transmission. The fundamental design for accomplishing this speed reduction/torque increase has remained relatively unchanged for over 30 years. The use of more advanced materials and manufacturing techniques has allowed manufacturers to improve durability and lower weight over the years, but the fundamental design concept is approaching the physical limits of improvement. Today, rotary-wing aircraft transmission systems comprise up to 11-percent of the aircraft empty weight. Newer, more advanced materials and designs are required to achieve significant gains in power/weight ratio, durability, reliability, and maintainability. One component that would benefit from these improvements is the rotor brake, which is widely used by Navy rotary-wing and fixed-wing aircraft. Rotor brakes, which are usually incorporated into the main transmission system, are notoriously heavy and very expensive, incurring both a weight and cost penalty. Gearbox housings would also benefit from advanced improvements. These housings currently have a high scrap rate due to corrosion induced by the Navy’s harsh operational environment. Advanced corrosion-resistant materials would provide substantial cost benefits by reducing the rejection rate of these components. The proper material selection could also provide a substantial weight savings.

PHASE I: Perform a feasibility study to identify novel main transmission and rotor brake design concepts. These design concepts should, at a minimum, analytically double horsepower-to-weight ratios of current baseline designs while improving reliability, increasing payload and/or range, allowing more flexible missions, and providing a greater margin of safety. Characterize the concepts and determine potential effectiveness based upon available data.

PHASE II: Downselect a design determined to have the greatest possibility of achieving the stated goals. Further develop and refine this design to include possible materials and manufacturing methods needed to produce any components critical to this concept. Document the analytical tools and methodology required in the design/manufacture of a prototype gearbox and rotor brake. Develop a test plan for bench testing of the design concept.

PHASE III: Team with a helicopter prime manufacturer or major DOD transmission supplier to manufacture and test a design concept demonstration gearbox with rotor brake, and use an evolutionary testing process to validate the new design methodology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Increased transmission power/weight ratio, reliability, maintainability, and durability would have significant potential for commercial applications.

REFERENCES:

1. AS3694A - Transmission Systems, VTOL/STOL, General Requirements for.

2. MIL-D-23222 - Military Specification, Demonstration Requirements for Helicopters.

KEYWORDS: Transmission; Durability; Power/Weight; Warfighter; Maintainability; Concept

N03-021 TITLE: Reduction of Rotary-wing Aircraft Driveshaft Deflection via Damping

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: ACAT IC: PMA-261: H-53/Executive Transport Helicopters , PMA-275: V-22

OBJECTIVE: Develop an active or passive means to reduce driveshaft deflection on rotary-wing aircraft.

DESCRIPTION: Rotary-wing aircraft transmit power over distances through the use of driveshafts incorporated into the transmission systems. Depending upon the specific application, the failure of a rotary-wing aircraft driveshaft will, at a minimum, result in a mission abort. Due to the tight internal clearances within aircraft compartments, failure of a driveshaft may also damage flight controls, hydraulics, and other critical systems, resulting in a loss of aircraft and aircrew. A damping system that minimizes driveshaft deflections will also reduce the loading on driveshaft end couplings and attach points, thereby increasing the life and reducing the maintenance requirements in this area. Acceptable damping systems may be active or passive. The damping system should be tailored to implementation in legacy aircraft applications and, as such, should require minimal aircraft modification to implement. The damping system resulting from this effort may be applied to any rotary-wing or other power shafting application, as well as to developing supercritical shafting applications (achieving weight and maintainability improvements) in a variety of rotary-wing aircraft.

PHASE I: Develop and evaluate the effectiveness of a proposed damping method to minimize driveshaft deflections. In addition to the reduction in shaft deflection, criteria to be considered include weight, cost, minimal aircraft moderations for installation, and maintainability/repairability. Assess the effectiveness of the design on both in-use shafting and supercritical shafting.

PHASE II: Develop a prototype and evaluate broadest range of driveshaft design applications to demonstrate the flexibility of the proposed system. The testing process will be used to quantify the effectiveness of candidate damping systems as well as refine the damping process.

PHASE III: Demonstrate the use of the developed damping system on in-service V-22 aircraft components.

PRIVATE SECTOR COMMERCIAL POTENTIAL: All commercial rotorcraft may benefit from the use of the resulting damping system. Industrial power transmission shafting may also benefit from this technology.

REFERENCES:

1. Joint Service Specification Guide 2009, Air Vehicle Subsystems, Appendix K.

2. AS3694A, Transmission Systems, VTOL-STOL, General Requirements for, 8 Dec 1976.

KEYWORDS: Driveshaft; Damping; Deflections; Active; Passive; Aircraft

N03-022 TITLE: Automated Interoperability Testing System

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop software architecture, process, and support tool(s) capable of providing automated testing and verification of candidate federates for acceptance into existing high-level architecture (HLA)-based federations.

DESCRIPTION: HLA is a new object-oriented approach to the development of interactive simulation models and environments. It is a means to control and direct simulation data toward only those entities/environments that have a need to know rather than forcing everyone to know everything. A federation is like a contract between simulations to agree on inputs, outputs, and common formatting.

Innovative processes and test architectures are sought that will provide more all-inclusive testing of candidate federates at different functional echelons from basic physical connectivity through complete logical interoperability. The effort required to bring new federates or simulations into existing federations is sizeable. Much of this effort results from a lack of significant pre-integration testing. The absence of a defined process or architecture that will facilitate interoperability and integration pre-testing of federates also means that efforts are duplicated each time these testing tasks are performed; it also opens the door to inconsistencies among different participants, since each can interpret requirements differently. The end results are longer integration times and increased costs. While there may be tools that facilitate federate integration through some form of pre-integration testing, they are normally limited in their functional scope, thus only promising limited interoperability and integration results. Furthermore, given that multiple functions and services of a federate may be interrelated, successful verification of individual services or functional areas does not guarantee true interoperability between the federate and the federation

Integration testing tasks will be automated wherever possible. The critical processes and areas of federation interoperability that must be examined include network connectivity, planning and execution data, runtime behavioral characteristics resulting from object and interaction exchanges, and federation object models. The results of this research will serve as an entry point for federates attempting to integrate within an existing federation. Once established, such a system can also serve as a vehicle for regression testing of federates, i.e., testing to determine errors resulting from the process of integrating a federate into an existing federation. The overall benefits are more consistent requirement implementation, significant reduction in integration time, and reduced costs.

PHASE I: Investigate pre-integration federate testing to identify potential federation integration problem areas and the methods that can be used to automate the recognition of integration obstacles as they occur. Investigate architectures for interfacing both existing federations and candidate federates/simulations. Ensure that such architectures facilitate easy configuration of repeatable automated tests to achieve different levels of testing for different federations or purposes. This research should also include the examination of feedback mechanisms from testing that extend beyond pass or failure determination to offer diagnostic and troubleshooting information. Test results should be stored for use after the tests are completed and should be in a form that will easily facilitate data sharing among other applications.

PHASE II: Implement the automated testing and verification architecture by prototyping the system described in Phase I and interfacing it with a specific federation and candidate federates. Detailed documentation outlining new processes and methodologies, along with user manuals and software design documents, should also be developed.

PHASE III: Produce and market the final system design.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The developed tool and processes will have applicability in any expanding or new HLA-based simulation programs.

KEYWORDS: Modeling; Simulation; Federation; Interoperability; Regression Testing; Automation

N03-023 TITLE: Digital Input/Output (I/O) Bus for Simulators

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Create a digital I/O data bus that reduces the associated costs and integration issues associated with building a real-time I/O system common in simulators.

DESCRIPTION: A method is required to reduce the complexity of designing, wiring, building, testing, troubleshooting and modifying simulator cockpits. This would be accomplished by shortening the distance from the physical I/O to the analog-to-digital (A/D) and digital-to-analog (A/D) conversion. Transmission of the electronic data representation would then be accomplished via an inexpensive distributed data bus interface based on commercial off-the-shelf (COTS) personal computing (PC) or gaming technology (e.g., Ethernet, USB, Firewire, etc.).

Current flight simulators require large numbers of digital inputs (e.g., switches, buttons, dials, etc.) and outputs (e.g., lights, indicators, relays, etc.) to support cockpit functions such as hands-on throttle and stick (HOTAS), control panels, and standby instruments. Typically, this requires building a large rack of I/O boards and running large bundles of wires. Many PC games currently have available joystick controllers for flight simulation games that simply "plug-n-play." However, these joystick controllers lack the physical fidelity required for procedural training in military applications.

A threshold solution would create a method to embed easily the digital conversion function in a HOTAS, control panel, or standby instrument with high physical fidelity, provide a direct link from the unit to a data bus, and be manageable via remote software. A training simulator cockpit would then have a distributed modular architecture capable of rapid re-configuration or modification.

This solution will also require a software configuration program and drivers for real-time application implementation. This would enable the rapid and inexpensive manufacture of a cockpit coupled with the ease of implementation and configuration of a joystick controller. Once integrated into a simulator, the configuration application and drivers should work together to minimize the impact of configuration changes to the hosting application.

PHASE I: Provide a comprehensive hardware and software design and a standard for implementing this interface. Provide test results that demonstrate the feasibility of the system and address issues of transport delay and reconfiguration. An objective solution will address analog I/O and controls for synchro-motors, radios, and multi-function displays.

PHASE II: Fabricate a functional digital I/O data bus based on the design architecture developed in Phase I. Test the implementation by running a simulator cockpit.

PHASE III: Produce the final system for Navy and commercial flight simulators.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The capability could be reused for any application where there are a large number of items that are part of a man-machine interface, as in commercial aircraft and the automotive industry. This capability could also be applied to older devices to decrease modification costs.

KEYWORDS: Cockpit; HOTAS; Man-Machine Interface (MMI); Real-Time Input/Output (RTIO); Simulators; Joystick

N03-024 TITLE: <u>Wide Field-of-View, Head-Mounted, Visor Optics</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop advanced lightweight, head-mounted visor optics for displaying high-resolution imagery.

DESCRIPTION: Long-standing problems associated with wide field-of-view head-mounted displays for ground-based simulator-training applications have been poor resolution, too much weight, and poor center-of-gravity characteristics. The resolution problem is being addressed though current efforts to develop color head-mounted imaging systems with greater than 5K x 4K, non-interlaced pixels. With these pixel counts a line pair subtends about two arcmin in an 83o x 66o image. In attempt to resolve the weight, center-of-gravity, and collimation problems, the Joint Strike Fighter (JSF) requires industry to design and construct lightweight, head-mounted visor optics for displaying high-resolution color imagery and symbology for situational awareness and targeting. The concept is to optimize the display’s center-of-gravity and incorporate projection optics with curved surface visor display materials that could be integrated into a flight helmet with wide field-of-view (FOV) projected out-the-window (OTW) imagery.

This topic builds upon current DoD efforts to provide head-mounted visual displays for flight simulation and other applications. In addition to addressing JSF requirements for training visibility through aircraft structures, the combination of these efforts will address a variety of simulation requirements for various fighter aircraft platforms. Such technologies will have a small footprint, thus enabling high fidelity, full field-of-regard, visual simulation for shipboard mission training and rehearsal of naval aircrews. This topic will also feed an Air Force critical experiment planned to begin in FY 06 focusing on developing OTW helmet mounted and deployable display technologies for distributed mission training (DMT) visual simulations. Collectively, this work will develop reliable, high-performance, deployable visuals including hardware and software that produces resolution, frame rates, field-of-view, and scene complexity required for realistic training in a fast moving aircraft visual system of the future.

This research would be coordinated with and supported by the Air Force Research Laboratory (AFRL), Warfighter Training Research Division (HEA), Mesa, AZ, so as not to duplicate efforts.

PHASE I: For head-mounted displays for ground-based simulator-training applications, establish the feasibility to develop lightweight, head mounted visor optics that optimize the display's center of gravity and incorporate projection optics with curved surface visor display materials that could be integrated into a flight helmet with wide FOV projected OTW imagery. Build benchscale components.

PHASE II: Develop, manufacture, and demonstrate the head-mounted visor optics prototype proposed under Phase I.

PHASE III: Transition the technology into ground-based simulator training applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: An improved lightweight, head-mounted visor optical system has the potential to provide tremendous improvements in weight and center-of-gravity characteristics of head mounted displays. This work, combined with ongoing Air Force efforts to increase image resolution, would have immediate benefit to the expanding world of virtual reality for industrial, medical, and special effects applications in the electronic media and motion picture industries.

REFERENCES:

1. MacDonald, L.W. and Lowe, A. C. (Eds.), Display Systems: Design and Applications. West Sussex, England: John Wiley & Sons Ltd., 1997.

2. Melzer, J.E. and Moffitt, K., Head Mounted Displays: Designing for the User. New York, NY: McGraw-Hill Companies, Inc., 1997.

3. Yu, K.H., Aye, T.A., Peppler, P.W., and Pierce, B.J., "Compact HMD Optic System Based on Multiplexed Aberration Compensated Holographic Optical Elements," presented at the 2001 Aerosense Conference, Orlando, FL.

KEYWORDS: Helmet Mounted Optics; Helmet Mounted Display; Visually Coupled System; Simulator; Crew Systems; Human Resources

N03-025 TITLE: Motion Imagery Navigation

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-281: Cruise Missiles Command & Control Program, PMA-265: F/A-18 Strike

OBJECTIVE: Develop innovative techniques to autonomously navigate air vehicles using motion imagery.

DESCRIPTION: A typical motion imagery camera mounted on an air vehicle will capture a series of electro-optical images along the flight path of the vehicle. Generally speaking, successive frames will overlap one another to a large degree depending on the speed of the vehicle and the frame rate of the camera. In addition, since the vehicle and camera are moving, common areas between a pair of images will have been taken from slightly different aspect angles. Thus, a series of stereo pairs can be formed. It is suggested here that the stereo nature of motion imagery can be exploited to generate an elevation profile in real-time. Further, the elevation profile can be correlated to a reference terrain map to provide a positional update for the air vehicle.

This research effort shall develop methods to implement motion imagery navigation. The effort shall consider and define significant camera and air vehicle parameters required to support this approach. The research shall consider navigation accuracy and robustness (probability of correct correlation) under varying conditions (terrain types, contrast, weather, vehicle maneuvers, etc.).

PHASE I: Develop a mathematical foundation for motion image navigation. Define critical camera parameters, air speed, and altitude limitations. Formulate the mathematical basis for processing a series of sensed frames to generate the terrain profile and correlating the profile to a pre-defined reference map. Estimate required computing resources to implement this approach in real-time. Estimate navigation accuracy and robustness under varying conditions.

PHASE II: Develop and demonstrate a prototype motion image navigator. The effort will validate and refine estimates provided in phase I.

PHASE III: Integration of the motion image navigation technique into an air vehicle.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability, which essentially provides an autonomous navigation feature, can be applied to commercial unmanned vehicles used by researchers and law enforcement for exploration of environments that are unsafe for humans.

REFERENCES:

1. U. R. Dhond and J. K. Aggarwal, "Structure from Stereo - A Review," IEEE Transactions on Systems, Man, and Cybernetics, vol. 19, pp. 1489-1510, 1989.

2. O. Faugeras, B. Hotz, H. Matthieu, T. Vieville, Z. Zhang, P. Fua, E. Theron, L. Moll, G. Berry, J. Vuillemin, P. Bertin, and C. Proy, "Real Time Correlation-Based Stereo: Algorithm, Implementations and Applications," INRIA Technical Report 2013, 1993.

3. A. E. Johnson, Y. Cheng, and L. H. Matthies, "Machine Vision for Autonomous Small Body Navigation," IEEE Aerospace Conference Proceedings, vol. 7, pp. 661-671, 2000.

4. J. J. Rodriguez and J. K. Aggarwal, "Matching Aerial Images to 3-D Terrain Maps," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 12, pp. 1138-1149, 1990.

5. D.-G. Sim, S.-Y. Jeong, R.-H. Park, R.-C. Kim, S. U. Lee, and I. C. Kim, "Navigation Parameter Estimation from Sequential Aerial Images," International Conference on Image Processing, vol. 1, pp. 629-632, 1996.

KEYWORDS: Computer vision; stereo imagery; navigation; DEM, Terrain

N03-026 TITLE: Imagery Automatic Extraction/Precision Placement of Cultural Features

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT II: PMA-205: Aviation Training Systems Program

OBJECTIVE: Develop automated imagery processing to retrieve and accurately position cultural features on geo-specific terrain.

DESCRIPTION: Traditional cultural data placement in digital terrain databases for training and rehearsal applications have relied on relatively low-confidence automated routines, or time- and labor-intensive manual methods. Opportunities now exist to exploit high-speed commercially available computing technology and accompanying statistical packages to achieve significantly increased precision and accompanying confidence figures-of-merit in the automation of these efforts. This effort would insert new technology into existing commercial off-the-shelf (COTS) imagery extraction platforms by developing algorithms to analyze, extract, and precisely locate imagery-derived cultural data in digital databases.

PHASE I: Develop a system design for an automatic culture extraction and placement system. This system should analyze imagery, recognize and mensurate cultural feature dimensions from stereo pairs, and conformally place culture of correct dimensions and texture in terrain databases utilizing standard data formats. Implement algorithms providing statistical confidence of results.

PHASE II: Develop and test the cultural extraction and placement system utilizing national imagery and a real-world terrain database. Demonstrate the reliability of the results.

PHASE III: Prepare user-friendly COTS tools for imagery analysts, cartographers, and database developers in civilian and military work environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This tool could be applied in imagery analysis, database development, mapping, charting, geodesy, land use, and environmental impact applications requiring rapid assimilation of cultural data from existing imagery sources.

REFERENCES: "Pathfinder 2001 Scene Visualization Data Production & Exchange (SVDP/E)," Final Report, National Imagery and Mapping Agency, December 2000.

KEYWORDS: Imagery Analysis; Cartography; Feature Extraction; Visual Databases; Sensor Databases; Database Tools

N03-027 TITLE: Useful Life Remaining Models for Turbine Engine Hot Section Components

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop useful life remaining models for turbine engine components. The intent is to develop models that will predict useful life remaining AFTER on-board systems have detected initial indications of a component failure.

DESCRIPTION: Current engine life management is based upon operational usage accounting and retirement at a predetermined total usage accumulation. To help ensure safety, generally life limits of flight critical hardware are a fraction of the probable usage that can accumulate before failure indications arise. However this does not account for the component that fails early or would have lasted for many times the safe life limit. Currently there is much research underway to develop techniques to detect initial failure indications of turbine engine components. This will enable the detection of prematurely failing components and could lead to the extension of safe life limits for flight critical hardware. Useful life remaining models are needed to provide usable information to the aircrew and aircraft maintainers.

The models should be general in nature and tailorable to the design of specific engines. The models should address intended and actual operational usage, deviation of engine performance from that expected throughout the operational envelope, and incorporation of existing and new sensing and diagnostic capabilities (i.e., vibration, temperature, disk, blisk, or blade crack or high cycle fatigue detection; exhaust debris monitoring, oil quality and debris monitoring; bearing health monitoring; etc.). The models should provide engine component useful life remaining in units that are characteristic of the specific component and an estimate of the accuracy of the prediction.

The models should be usable in software open architectures such as OSA-CBM (Open System Architecture for Condition Based Maintenance).

PHASE I: Develop useful life remaining model for engine hot section components that addresses at a minimum actual and anticipated operational usage, actual and anticipated deviations from model performance, and engine gas path performance feedback information.

PHASE II: Refine prototype design using modeling, simulation, and analysis. Demonstrate design in a laboratory type setting that can mimic the erosive, corrosive, and abrasive environments experienced by gas turbine engines. Demonstrate system on engine hardware in a test cell environment.

PHASE III: Incorporate engine hot section useful life remaining model on existing and new production aircraft, making any necessary modifications to the maintenance and support concepts.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A engine useful life remaining models have broad application to commercial aviation, shipping, and locomotive industries.

REFERENCES:

1. Henley, Captain Simon, Currer, Col. Russ, Sheuren, Dr. Bill, Hess, Andy, and Goodman, Geoffrey. "Autonomic Logistic--The Support Concept for the 21st Century," IEEE Proceedings; Track 11, Paper zf11_0701.

2. Byer, Bob, Hess, Andy, and Fila, Leo. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics," Aerospace Conference 2001, IEEE Proceedings, Vol. 6, 2001, pp. 3095, 3103.

KEYWORDS: Condition Based Maintenance; Diagnostics; Prognostics; Turbine Engine; Components; Hot Section

N03-028 TITLE: Fault-to-Failure Progression Modeling of Propulsion System and Drive Train Clutch Systems for Diagnostics, Prognostics, and Useful Performance Life Remaining Predictions

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop and demonstrate incipient fault-to-failure progression models, advanced prognostic models, statistical techniques, and other programs that can be used to relate accurate useful life remaining predictions for various types and degrees of fault and failure conditions in propulsion system and drive train clutch systems.

DESCRIPTION: In order to fully enable the predictive part of any prognostic and health management (PHM) concept, there has to be some capability to relate detected incipient fault conditions to accurate useful life remaining predictions for any point in time. The key to accomplishing this is being able to understand incipient fault-to-failure progression characteristics for propulsion system and drive train clutch applications; and developing realistic and verifiable prognostic models for useful life remaining predictions. This may be accomplished through the merging of the physics of failure, analytical models, physical models, statistical techniques, and actual bearing failure data. It is recognized that clutch system failure mechanisms and the understanding of the fault-to-failure progression characteristics are unique to their application and are different than other aircraft components. Therefore, the resulting techniques, tools, and prognostic models will be unique to the clutch system application. Some level of real-time sensor and/or measurable state awareness will be a required input to these prognostic models and techniques. This effort will develop, demonstrate, and apply these innovative and advanced diagnostic, prognostic. and useful life remaining models in support of the predictive part of PHM on clutch systems and their components.

PHASE I: Define the techniques and processes needed to relate useful life remaining predictions to detectable fault conditions in propulsion system and drive train clutch systems and their components. Report on a strategy to develop the advanced models, statistical techniques, and other programs required. Establish and demonstrate the feasibility of the proposed techniques, tools, and models to predict accurate useful life remaining.

PHASE II: Develop, demonstrate, and validate a prototype for these advanced models, tools, techniques, and programs for a specific propulsion system and drive train clutch systems. Assess the application boundaries, accuracy, and limitations for these modeling techniques. Show the potential to integrate these capabilities with a comprehensive PHM system.

PHASE III: Finalize these models with a major aircraft or engine manufacturer. Apply these modeling programs on a new aircraft development program like the JSF.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These advanced models would be applicable to any propulsion system and drive train application that will be applying a clutch system and diagnostic, prognostic, and health management capabilities. Any results gained from applying these failure progression rate models to particular propulsion system and drive train clutch system will provide a significant crossover benefit to other similar applications, commercial or military. This potential benefit area would not be limited to aviation applications but anywhere clutch systems are used.

REFERENCES:

1. "AUTONOMIC LOGISTIC-THE SUPPORT CONCEPT FOR THE 21st CENTURY", by Captain Simon Henley, Col Russ Currer, Dr. Bill Sheuren, Andy Hess, and Geoffrey Goodman ; IEEE proceedings; Track 11, paper zf11_0701

2. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics", by Bob Byer, Andy Hess, and Leo Fila; Aerospace Conference, 2001, IEEE Proceedings, Volume: 6, 2001; Pages 3095, 3103

KEYWORDS: Diagnostics; Prognostics; Modeling; Useful Life Remaining Predictions; Prognostic and Health Management (PHM); Clutch Systems; Failure Prediction

N03-029 TITLE: <u>Acoustic Emission Monitor for Drive System Coupling Crack Detection</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop reliable, near real-time monitoring methodology for early detection of cracks in diaphragm-type couplings used in aircraft and engine drive systems that can provide suitable advance warning to pilots and maintenance personnel to preclude catastrophic failure.

DESCRIPTION: Diaphragm-type couplings may develop cracks that do not produce imbalance and are not detectable by typical vibration sensors, particularly in the early stages of the crack growth. It is known that metallic structures generate characteristic high-frequency stress waves (i.e., produce acoustic emissions) during crack growth/propagation cycles. The goal is to develop a sensor/software system that will detect the high frequency stress waves generated by a rotating cracked coupling. The system must be capable of detecting, identifying, monitoring, and isolating coupling cracks on an operational aircraft system, and provide sufficient advance warning to preclude catastrophic failure.

PHASE I: Determine the technical merit of the proposed technology and software to monitor and identify cracks in diaphragm-type couplings of aircraft and engine drive systems. Build brass board components to demonstrate this approach.

PHASE II: Develop a prototype coupling crack monitoring system for use on an operational aircraft/engine system that will detect, identify, monitor, and isolate cracks and provide sufficient advance warning to preclude catastrophic failure.

PHASE III: Transition the coupling crack monitoring system into a fleet of aircraft as an enhancement to resident health management systems, as a sensor/software system that is integral with the drive system that can detect and monitor coupling cracks in near real-time. Post-processing and trending of onboard data following flight and ground operations are acceptable, but the goal would be to provide real-time onboard crack detection capability.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Many commercial aircraft use diaphragm-type couplings in drive systems and engines. The coupling crack monitoring system could be used to enhance overall system safety of any health management system.

REFERENCES:

1. Singh A., "Detecting Gear Tooth Breakage Using Acoustic Emission: A Feasibility and Sensor Placement Study", Proceedings of 1998 ASME Design Engineering Technical Conference. Sep.13-16, 1998

2. Pollock A., " Acoustic Emission Inspection", Physical Acoustics Corporation, TR-103-96-12/89

KEYWORDS: monitoring; diagnostics; drive systems; fault detection; crack detection; couplings

N03-030 TITLE: <u>Increased Impact Protection of the Navy's Aviator Helmets</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMA-202: Aircrew Systems Program

OBJECTIVE: Improve the impact protection of the Navy's current aviator helmets by developing a new energy absorbing liner.

DESCRIPTION: The primary function of Navy aviator helmets is head protection, especially impact protection. The Navy's current family of helmets, the HGU-68/P (ejection aircraft) and the HGU-84/P (rotary wing aircraft), provide protection utilizing a combination of a Kevlar outer shell and a styrofoam Energy Absorbing (EA) liner (which is force fit into the Kevlar shell). While the protection provided by these helmets meets the Navy's basic impact requirement established decades ago, it is believed that they could probably do a better job. The US Army has, in the last few years, established an impact requirement that the Navy's current helmets do not meet.

The Navy is interested in upgrading its inventory of helmets so they meet the newer impact requirement established by the Army. The final goal of this program is the replacement of the EA liners in the Navy's current helmets with new EA liners. The replacement EA liners, when combined with the outer shell, should increase the impact protection while not increasing the weight of the helmet or making it otherwise uncomfortable to wear. It is important that the cost of replacing the EA liner not be so prohibitive that it would be cheaper to buy new helmets. A secondary goal, if possible, is to reduce the weight of the Navy's helmets. Of course, it is essential that the materials chosen not give rise to any health problems for either the wearer or the maintainer.

PHASE I: Determine technical merit of alternative energy absorbing materials for use based on energy absorbing characteristics, manufacturability, cost, weight, and durability. Begin to design new EA liners using candidate materials, focusing on the size Large helmet shell (There are currently 4 sizes: Medium, Large, Extra Large, and Extra Large Wide). Test materials and provide analysis of text results.

PHASE II: Manufacture and impact test a small quantity of prototype helmets using EA liners made from materials defined in Phase I. Refine design, manufacture a limited quantity of EA liners and perform more extensive testing.

PHASE III: Manufacture a large quantity of EA liners to prove manufacturability. Demonstrate durability, ease of replacement, and comfort of new liners. Perform final, Safe to Fly qualification testing on modified helmets.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Everywhere protective helmets are needed, cycling, motor sports, emergency response, etc… The need to absorb impact energy is not limited to helmets. Any place a "crush zone" is needed can benefit from the development of light, energy absorbing materials.

REFERENCES:

1. MIL-H-87174 (USAF) Helmet Flyers' HGU-55/P

2. Procurement Document 60248-93-1a, Helmet Assembly, Aircrew, HGU-84/P;

3. USAARL Report 96-4, Performance Assessment of the HGU-84/P Navy Helicopter Pilot Helmet;

4. USAARL Report 97-1, RAH-66 Comanche Health Hazard and Performance Issues for the Helmet Integrated Display and Sighting System

5. (ANSI) Z90.1,1971; USAARL Report No 97-1,

KEYWORDS: helmets; energy absorbing; impact protection; safety; materials; Styrofoam

N03-031 TITLE: H-60 Mission Avionics Technology Insertion

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

ACQUISITION PROGRAM: PMA-299: Multi-Mission Helicopters Program; PEO(A)

OBJECTIVE: Research innovative system designs for the H-60 Avionics systems that provide an open architecture that is scalable and allows for seamless technology insertion and integration, thus providing reduced life cycle costs and risk mitigation to the program.

DESCRIPTION: Current H-60 hardware is ROTS (Ruggedized Off the Shelf) and although ROTS is less expensive than proprietary developed hardware, the cost is still projected to be significantly higher than commercially available alternatives. Within the next five years, many of the single board computer (SBC) boards and I/O cards will require redesign as the current microprocessors become obsolete and out of production. Rather than redesign boards or perform end of life buys, a different approach for replacing these SBCs needs to be developed which takes into account the short life span of computer hardware. This new approach should immunize future systems from obsolescence due to the rapid changes in the technological landscape, while allowing the system to take advantage of those advances as the commercial world evolves more capable components.

PHASE I: Determine the feasibility of providing a technology insertion architecture for the reduction of program dependencies on ROTS-based components. The primary area of investigation would be the feasibility of replacing ROTS computer cards with true COTS cards; developing processes to coat COTS cards; and harden the enclosure such that true COTS can be used in a military environment.

PHASE II: Create prototype Weapons Replaceable Assembly (WRA) using this technology insertion architecture using components which meet the Navy's temperature, vibration and salt water requirements for Helicopters.

PHASE III: Transition new technology architecture to the tactical system during Full Rate Production of aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial helicopter industry, as well as most DoD aircraft, could potentially use this technology to enhance their abilities to transition to new technology equipment and reduce program costs.

KEYWORDS: Ruggedized; Single Board Computer; Sealed Motherboards; Obsolescence; Avionics; Open Architecture

N03-032 TITLE: Sonobuoy Launcher

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: ACAT IC: PMA-299: Multi-Mission Helicopters Program

OBJECTIVE: Develop a lightweight sonobuoy launcher capable of recognizing sonobuoy types and sizes.

DESCRIPTION: Helicopter platforms, such as the MH-60R multi-mission helicopter, are combat extensions of the surface combatant. In an undersea warfare role, the MH-60R conducts defensive and/or offensive operations in support of the battle group or task force. Reducing weight on the MH-60R increases its available time on station. A lightweight sonobuoy launcher system is sought that provides the following capability improvements over the current legacy system:

- Superior (safer and more reliable) firing mechanism through the use of innovative ejection approach.
- Improved structural performance by the use of either metal or composite design, e.g., shape, size, weight, and static and dynamic performance that provides at least a 15-year life cycle.
- A 25 A-size sonobuoy capacity with provisions for smaller size sonobuoys.
- Remote function select (RFS) capability in the launcher, allowing prelaunch stores life, depth and mode reconfiguration, and mission-dictated changes in flight.
- Capability to also serve as a launcher for decoys and chaff.
- When used as a decoy or chaff dispenser, allow for the “programming” of predetermined self-defense sequences.

PHASE I: Determine lightweight sonobuoy launcher operational requirements, performance envelope, and preliminary design to meet a 50-percent decrease in size and weight and determine interface requirements to provide the RFS capability. Determine feasibility of meeting the design criteria established above. The analysis and design shall employ the MH-60R as the transition platform and allow provisions for the SH-60B LAMPS MK III helicopter.

PHASE II: Develop a prototype lightweight sonobuoy launcher that meets the design criteria. Conduct initial environmental qualification. Perform reliability and maintainability predictions. Conduct testing that allows for proof of design. Develop a concept of operation using the lightweight sonobuoy launcher and available sonobuoy types and sizes in the Fleet for the MH-60R.

PHASE III: Transition the lightweight sonobuoy launcher to the SH-60B LAMPS MK III and MH-60R multi-mission helicopter.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Development of “smart” and lightweight ordnance dispensing systems can be employed by law-enforcement, environmental monitoring, drug enforcement, and biological monitoring agencies. These aerial dispensing systems provide the capability to reach dangerous and inaccessible locations.

REFERENCES:

1. N78, Draft “Air ASW Concepts of Operations (CONOPS) for the Maritime Patrol & Reconnaissance Force of the 21st Century,” 28 Jun 02.

2. Program Executive Officer (PMA-299) Air ASW, Assault, and Special Missions Programs, “Technology Issues,” 25 Feb 02.

3. Program Executive Officer, Air ASW, Assault and Special Mission Programs Memorandum Ser PEO(A)/114-01, Subject: CALL FOR AIR ASW ADVANCED TECHNOLOGY REVIEW BOARD (ATRB) SUBMITTALS, 12 Oct 01.

4. Program Executive Officer (PMA-264) Air ASW, Assault, and Special Missions Programs, "Production Sonobuoy Specification For Bathythermograph Transmitting Set AN/SSQ-36B and Sonobuoys AN/SSQ-53F, 62E, 77C, and 101," 19 Oct 00.

KEYWORDS: Sonobuoy; Launcher; Aerial Dispensing; Sonobuoy; Weight Reduction; Lightweight

N03-033 TITLE: Mid-Frequency Sonobuoy

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: ACAT IC: PMA-299: Multi-Mission Helicopters Program

OBJECTIVE: Develop a lightweight mid-frequency sonobuoy capable of operating as a receiver for the surface combatant bow sonar and the variable-depth airborne low frequency sonar (ALFS).

DESCRIPTION: Helicopter platforms, such as the MH-60R multi-mission helicopter, are combat extensions of the surface combatant. In an undersea warfare role, the MH-60R conducts defensive and/or offensive operations in support of the battle group or task force. With the reduction of passive target signatures and increased operations in shallow waters, the use of active sonar systems for undersea warfare missions will yield the highest payoff. This payoff can be significantly increased through the use of multi-static receivers for the active sonar sources, thereby increasing the aspect-dependent target echo returns. Currently, there are no passive mid-frequency sonobuoys that can operate in a multi-static mode as receivers for the surface combatant bow sonar and the ALFS. A new mid-frequency passive sonobuoy would allow multi-static operations with the high-power bow sonar source and the variable-depth ALFS sonar, thereby achieving wide area searches and greater protective standoff distances. A new mid-frequency sonobuoy is sought that provides the following capabilities improvements:

- A minimum of 12 receive beams (with a goal of 24) to further reject reverberation and localize the target in azimuth.
- A directivity index of at least 12 dB.
- Real-time adjustable receiver dynamic range based on in-situ background noise levels.
- In-buoy beamforming to reduce radio frequency data transmission requirements.
- Digital sonobuoy data in 32-bit IEEE double precision floating point format.
- Digital uplink (an improved frequency shift key (FSK) modulation since the current FSK technique only supports an uplink rate of 256 kbits/sec).

PHASE I: Demonstrate the technical feasibility of developing and packaging a mid-frequency sonobuoy that is operationally compatible with the surface combatant sonar and the ALFS in an A-sized sonobuoy form factor, at a price that will permit improved spatial coverage in shallow waters and littoral regions during undersea warfare missions. Investigate and determine the mid-frequency sonobuoy operational envelope and design requirements in order to achieve a 40-percent weapons system operational performance increase over the low frequency passive sonobuoy. The analysis should compare passive sonobuoy performance versus a new mid-frequency sonobuoy serving as a multistatic receiver for the surface combatant bow sonar and the ALFS variable-depth sonar.

PHASE II: Develop a prototype mid-frequency sonobuoy that meets the design criteria. Conduct initial environmental qualification. Perform reliability and maintainability predictions. Conduct testing that allows for proof of design. Develop a concept of operation using the mid-frequency sonobuoy with both the surface combatant bow sonar and the ALFS variable-depth sonar.

PHASE III: Transition the mid-frequency sonobuoy to the MH-60R multi-mission helicopter.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Development of new sonobuoys at higher frequencies than previously achieved leads to smaller and lighter systems. Undersea mapping, exploration, and navigational systems employ higher frequencies, some included in the mid-frequency regime.

KEYWORDS: Passive Sonobuoy; Mid-Frequency Acoustics; Bi-Statics; Multi-Statics; Bow Sonar; ALFS

N03-034 TITLE: Advanced Multi-Aircraft Shipboard Landing Model

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: ACAT ID: PMA-276: H-1 Program

OBJECTIVE: Develop an advanced, fully coupled aerodynamic model to support multi-aircraft/ship dynamic interface analysis and testing.

DESCRIPTION: The dynamic interface problem refers to shipboard landing of aircraft and represents one of the most challenging technical areas of research and development. It involves determining the operational limits of a specific aircraft operating aboard a specific class ship. Factors like ship airwake/turbulence, number of aircraft operating simultaneously, ship motion, restricted landing deck size, and possible restricted visual cues complicate the landing task. Progress has been made in analyzing the single aircraft shipboard landing task, but this progress does not include the interference associated with multi-aircraft operations on the same ship and at the same time. The interaction of the ship's airwake with the airframe, the effect of stationary and turning aircraft on the flight deck, the interaction of the aircraft downwash with the ship's deck, and the resulting ground interference on the airframe complicate the analysis of the shipboard landing environment. The problem is further complicated with tiltrotor aircraft due to the interaction of the two main rotors with each other and with the deck. Limited work has been conducted to develop a dynamic interface simulation capability, including making at-sea ship airwake measurements. Currently, no simulator can be used to develop rotorcraft/ship operational envelopes. A high-fidelity interactional aerodynamic model for multi-aircraft/ship operations is required to support future aircraft/ship testing.

PHASE I: Develop the best approach to formulate n-dimensional ship airwake turbulence associated with multi-aircraft/ship operations and the best approach to model the interference effects associated with multi-aircraft/ship operations. Include a plan to couple the aircraft, ship airwake, aircraft interference, and ship motion.

PHASE II: Develop the advanced multi-aircraft/ship aerodynamic interference models to support the aircraft shipboard landing task analysis. Validate the fully coupled aerodynamic model against available flight test, wind tunnel, and analytic data. Demonstrate the application of the advanced ship landing module to specified aircraft types and to specified ship classes. Demonstrate the model's capability to predict aircraft ship operational envelopes to enhance future ship-based flight testing.

PHASE III: Provide a validated multi-aircraft aerodynamic interference model to support multi-service and commercial aircraft/ship operational requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The improved multi-aircraft aerodynamic interference model could be used to facilitate future commercial airline landing zone planning and passenger boarding planning. New advanced multi-aircraft/ship interference models could be used to benefit all commercial rotorcraft builders, testers, and operators, with specific benefit to commercial roof top rotorcraft operators.

REFERENCES:

1. Williams, S. and Long, K., "ADS-33 and Shipboard Rotorcraft Operations: A USN Flight Test and Simulation Perspective," presented at the AHS 53rd Annual Forum, Virginia Beach, VA, Apr. 29-May 1,1997.

2. Padfield, G. and Wilkinson, C., "Handling Qualities Criteria for Maritime Helicopter Operations," presented at the AHS 53rd Annual Forum, Virginia Beach, VA, Apr. 29-May 1, 1997.

3. Carico, Dean et al., "Rotorcraft/Shipboard Landing Analytic Options," presented at the SFTE Symposium 32, Seattle, WA, Sept. 2001.

KEYWORDS: Interactional Aerodynamics; Aerodynamic Interference; Dynamic Interface; Ship Airwake; Simulation; Aircraft/Ship Testing

N03-035 TITLE: Development of a Crack Resistant Durable concrete Repair Material for Navy Concrete Structures

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Naval Facilities Engineering Command,Shore Facilities Advanced Development

OBJECTIVE: Develop a concrete repair material that is twice as durable as current technology used by the Navy and the concrete repair industry.

DESCRIPTION: On a national level it has been recognized that the durability of repaired concrete structures is a topic of increased concern. In recent years the image of concrete has been shaken by durability problems, by often-poor performance, and most of all, by concrete repair failures.

Within the Navy, experience shows that most concrete repairs in the tidal zone, in semi-tropical marine environments, have a limited life expectancy of about 5 to 7 years.

Generally, it is the objective of the owner and contactor to strive to accomplish a repair with a life of 20 years. In practice the effective life usually falls short of this objective. For repairs associated with expansive by-products produced by corrosion of the steel reinforcement, it is common to see new delaminations occur adjacent to patches in 1 to 3 years.

Navy concrete structures are in the state of deterioration and many of these structures, especially those in marine environments, were repaired only 3 to 7 years earlier. The Navy is facing a major challenge: How to successfully repair our facilities so as to prolong their service life. This problem is not limited to the Navy; the premature degradation of concrete structures exposed to severe environments is a multi-billon dollar problem in North America. For instance, conservative estimates of the current cost to rehabilitate deteriorated concrete structures in United-States are in the $100 billion dollar range.

Durability of concrete repairs, to a large degree, depends on the correct choice and use of repair materials. Unfortunately, the materials we are using today do not meet the requirements for crack resistance and durability. Commercially available concrete repair materials are intrinsically crack-prone, and are generally unsatisfactory for Navy use.

Deterioration and distress of repaired concrete structures in service are a result of a combination of physical and chemical processes such as the corrosion of embedded reinforcing steel, alkali-aggregate reaction, delayed ettringite formation, etc. These processes are accelerated by the cracking of the repair materials thus allowing the ingress corrosive elements such as water, salts, carbon dioxide, sulfates and oxygen, into the concrete.

The bond of the repair material to the concrete substrate physically restrains the repair material. Although the bond is essential, it is a major factor leading to cracking and the eventual delamination and failure of the repair material. In simple terms, the repair material cracks when the tensile stress exceeds the tensile strength. While development of tensile cracks may be favorable from the point of view of stress redistribution in the concrete, the situation becomes extremely different when judged from the point of view of concrete's ability to resist the penetration of corrosive elements.

In concrete and other cement-based materials, microcracks already exist at the interfaces of the aggregate-mortar and reinforcement-mortar. When large, visible cracks become interconnected with microcracks, the network of cracks facilitates the transport of aggressive ions and gasses to the embedded reinforcement, leading to premature corrosion and deterioration.

What are needed are repair materials that are durable. Durable repairs require a two fold approach, first repair materials and strategies that address on-going corrosion adjacent to the repair and crack resistant materials. This is in conflict to what the repair industry currently markets, which are materials that are high-strength, and in most cases, high early-strength. Ironically, the material properties that contribute to high strength are counter-productive to accomplishing durability. Long-term durability is achieved by dimensional stability, which means less stress from thermal contraction, autogenous shrinkage, and drying shrinkage. The combination of factors affecting crack resistance is called "tensile strain capacity" or "extensibility". Cracking of concrete can be managed by controlling the extensibility of the material. Cement-based materials with large extensibility can be subjected to large deformations without cracking.

Development of a "Crack Resistant Durable Concrete Repair Material" must account for several important factors, including:

- Long life in marine and other severe environments
- Extensibility
- Crack resistant
- Volume stability
- Ease of placement and compaction

The SBIR Contractor shall establish guidelines for the concrete repair material, which may include factors with respect to crack resistance. For example:

Cracking Criteria
Drying shrinkage: not to exceed
- at 28 days 400 millionths
- at 1 year 1,000 millionths

Restrained shrinkage:
- No cracks within 14 days
- Implied strain at 1-year age, not to exceed 1,000 millionths

Test Method
ASTMC 157 (Modified according to US Army Corps of Engineers Technical Report REMR-CS-62, 1999, p.A3)

AASHTO PP 34 - 99, "Standard Practice for Estimating the Cracking Tendency of Concrete."

PHASE I: Identify short-term laboratory material criteria for crack resistant performance. Develop candidate concrete mixture/s. Test candidate concrete mixture/s for compliance to the crack resistant criteria selected by the SBIR contractor and Report results.

PHASE II: Identify long-term material performance criteria for application at diverse Navy locations, eg. Pearl Harbor, HI; San Diego, CA; and Norfolk, VA. Validate performance of candidate concrete mixture/s. Test candidate concrete mixture/s for compliance with crack resistant criteria at various exposures. Report results.

PHASE III: Prepare MSDS, application instructions, quality assurance program for manufacture of the product proper application. Demonstrate full-scale repair at the three diverse locations. Quantify cost and life cycle savings. Small business will sell the product to the repair contractor.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The concrete repair material will be used primarily in marine concrete and airfield pavements. The product will be marketed and sold to the concrete industry worldwide.

REFERENCES:

1. ICRI No. 03731 Guide for Selecting Application Methods for the Repair of Concrete Surfaces

2. ICRI No. 03733 Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces

KEYWORDS: Concrete repair; corrosion; deterioration; durability; extensibility; shrinkage

N03-036 TITLE: Microturbine Fuel Pump Life Extension

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Public Works, NAVAL Shore Facilities Energy Demonstration and Validation

OBJECTIVE: Increase the life expectancy of Microturbine fuel pumps from 4000 hours to 16000 to 20000 hours and still maintain adequate fuel pump pressure and flow rate required for Microturbines. Microturbines can range in sizes from 30 kW to 200kW, this proposed fuel pump must be compatible with the Microturbine and maintain the fuel pressure and flow rates required for operation.

DESCRIPTION: Microturbines produce both heat and electricity. They provide the Navy with the opportunity to reduce energy costs, reduce greenhouse gas emissions, provide electric power during peak demand periods, and provide emergency backup power in the event of a natural disaster or an act of terrorism. This is because they have a small number of moving parts, coupled with low emissions, and are compact and lightweight. In general to be cost efficient they need to be coupled with waste heat recovery systems to achieve efficiencies greater than 80%. Generally, Microturbines have a life expectancy of 40000 hours before they need to be overhauled. The fuel pumps are replaced every 4000 hours about ten times throughout the life of a Microturbine. Increasing the life of the fuel pump will decrease down time and labor costs for replacing unique internal components. At present Microturbines suffer in cost comparisons with conventional generation technologies – and improvements are needed to close the cost differential to make them applicable for the first choice of users.

PHASE I: Develop concepts for extending the life expectancy of fuel pumps and determine the feasibility associated with these concepts. The feasibility study for this shall include developmental costs, prototyping costs, production costs, and market prices for the new and improved fuel pumps.

PHASE II: Design, build, test, and evaluate prototype fuel pumps. Develop plans for large-scale production or mass marketing.

PHASE III: Produce a packaged fuel pump for commercial off the shelf procurement and a user data package to facilitate the use of these fuel pumps throughout the Navy and Commercial Sector.

PRIVATE SECTOR AND COMMERCIAL POTENTIAL: The commercial sector has installed microturbines at their facilities where local conditions provide effective subsidies to improve their cost differential with conventional generating systems. The costs for heat recovery, materials and reliability are some of the limiting factor for commercial applications. Producing long lasting fuel pumps is one component for ensuring improved life cycle costs of existing microturbines. Grid connected microturbines could be developed using a distributed design able to operate on a wide range of fuels – such as gasoline, diesel or LNG.

KEYWORDS: Microturbine compatible fuel pumps, Fuel pumps for Microturbines, or Microturbine fuel pump. Distributed Generation; Combined Heat and Power (CHP); Co-generation; Life Cycle Costs; Greenhouse Gas Emissions, Base Energy Security

N03-037 TITLE: Data Model for Battle Force Interoperability Certification

TECHNOLOGY AREAS: Information Systems, Battlespace, Weapons

ACQUISITION PROGRAM: NAVSEA 53

OBJECTIVE: The objective of this project is to develop a model for acquiring, organizing, storing, distributing, and analyzing the combat systems data that results from interoperability tests, corrective actions, upgrades and modifications, during the D-30 process. The analyses are to assist in the determination of readiness, planning modifications and assigning them priorities taking account of budgets and criticality. System architecture is to be developed for the implementation of this model; hardware, network, and COTS product components are to be evaluated and selected to create a working system representing the selected architecture. This is to include a data archiving system needed for analyzing the historical data.

Proof of concept is to be provided to demonstrate the model's usefulness as well as the assembled system's flexibility, platform and operating system independence, scalability and reliability, and conformance with the secured data transmission and processing requirements. After the completion of proof of concept demonstrations and evaluation of user feedback, the initial version of the working system is to be developed that can function with the legacy source databases. Simultaneously, a transition process is to be put in place to incorporate new as well as streamlined source databases, and new application programs that use the warehouse data to generate information that can be used by the decision makers.

DESCRIPTION: The core of the model is a system that includes capabilities for: (a) class definitions, tools for data acquisition and object instantiation; (b) hardware and software for object data storage and query processing (locating and accessing requested objects); (c) utilities for memory management, conducting backups and recovery, load balancing, assigning classification levels, and controlling access. This system has to be flexible to accommodate schema evolution and scalable to accommodate larger data volume and number of concurrent users. The locking mechanisms have to be capable of safeguarding the integrity of data and transactions, and, the same time, designed to minimize the probabilities of performance degradation and gridlocks.

This core element is to be provided with a system for interrogating distributed, heterogeneous, source databases, to acquire data for object-attribute values. Since these values must change as the deficiencies recorded during the interoperability tests are corrected, or as the newer versions of system elements replace the old, the model has to have the versioning capability as well as the archiving capability (that must be provided process and trend analyses).

On the client side, the model has to be capable of providing inputs to application programs for programmatic as well as mission analyses.

PHASE I: The objective of work during Phase I is to develop a prototype to show that a representative sample of source data maintained on a commercial relational database management system can be acquired, objectified, and furnished to a client application for use. Also, to demonstrate that the data transfer can occur over a secured data network.

PHASE II: The objective of Phase II is to develop a working system that can be used to communicate with the user community, to obtain feedback, so that the specification for a full working system can be developed.

PHASE III: The objective of Phase III is to develop the initial working system that can work with the legacy data sources, and to the maximum extent possible, with the existing computing and network facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The problem of determining the readiness and interoperability extends from naval task forces to multi-service and multi-country forces engaged in joint and combined operations. The system that is developed under this project is expected to be of interest to The US Joint Chiefs of Staff and NATO.

KEYWORDS: Battle force Readiness; Combat Systems Interoperability; Object-Oriented Distributed Data Processing in a Classified Environment.

N03-038 TITLE: Computer Aided Identification of Mines

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-MUW, PMS-210, Program: AQS-20(A), AN/WLD-1

OBJECTIVE: Develop real-time computer aided mine-identification capability to facilitate rapid in-stride mine countermeasures.

DESCRIPTION: Electro-optic sensors have been demonstrated to provide a powerful discriminant for mine identification, and these sensor systems are being integrated into the AQS-20(A) towed minehunting system. Mine identification is currently performed by post-mission analysis, requiring substantial operator workload and resulting in significant delays in completing the identification mission. Computer-aided identification could be performed in-flight, reducing both operator workload and mission timeline.

PHASE I: Develop candidate identification algorithms and demonstrate capability for computer-aided mine identification. Evaluate both probability of correct identification (Pid) and false identification rate, with specific emphasis on exploitation of 3-D information.

PHASE II: Using the most promising algorithms identified in Phase 1, optimize the algorithms to be robust against variable mine threats and environmental conditions. Quantify PID over the anticipated operational envelopes. Evaluate suitability for real time execution on common workstations.

PHASE III: Implement optimized algorithms in real time computer systems, and provide capability to operational navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Object identification is required for various ocean surveillance applications, such as pipeline inspection, geophysical exploration, and search and rescue operations. Computer-aided identification would significantly enhance these commercial applications.

KEYWORDS: Electro-Optic Identification, Computer Aided Identification, Mine Countermeasures

N03-039 TITLE: Alternative System for Hangar Bay Access Doors

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 378: Next Generation Aircraft Carrier

OBJECTIVE: Develop a new system for opening, closing, and locking hanger bay access doors. The new system shall replace the existing electric motor, gear reducer, winch drum, multiple sheaves, and wire ropes.

DESCRIPTION: The existing hangar access doors require multiple mechanical components for opening, closing, and locking of the doors. Typical driving machines for these doors include a 50 HP electric drive motor, gear reducer, electric brake, winch drum, multiple sheaves, and wire ropes. The drive motor, through the gear reducer and winch drum, opens and closes the door by pulling wire ropes that are attached to the door panels. The total length of wire rope varies from 800 feet to 1300 feet. There is a high failure rate due to the numerous drives, locking, and safety components. These doors also require a track in the hangar deck where a structural blast bar travels, and in some cases, this track collects debris and water, which requires many maintenance hours for cleaning. Corrosion is often a big issue with this system. Many maintenance hours are spent on corrosion prevention, which is difficult to accomplish due to component access problems. Furthermore, the existing door drive system has a history of frequent parting of wire ropes on the door panels. This has resulted in thousands of hours of downtime throughout the fleet. Technologies, such as, linear induction motors, linear actuators, or magnetic levitation would rid the system of such design problems and increase reliability while improving maintainability. These are examples of only a few technologies that could be used but should not necessarily be the only ones considered. It is estimated that the implementation of an alternate system could result in an overall reduction in maintenance hours of approximately 60%.

The desired system shall be required to operate without the use of hydraulics or any other hazardous material/fluid. It shall be required to open and close the deck edge doors in 60 seconds and the hangar doors in 20 seconds. Current deck edge doors utilize two panels approximately 37 ft. long, 13 in. wide and 25 ft. high and weigh approximately 50,000 lbs each. The system shall hold/lock the panels in position at the ends of travel and any intermediate point. It shall require minimal maintenance with a Mean Time between Failure (MTBF) of 10,000 hours. System shall contain intelligent controls that will provide information to an operator's panel to include, but not limited to, system status, troubleshooting information, and maintenance information. System shall at the very least maintain the level of safeties of the current system. System shall meet shock, vibration, and EMI requirements in accordance with MIL-S-901D, MIL-S-167-1, and MIL-STD-461E, respectively. It shall also have a secondary method of operation in the event of a failure of the primary operating system. The secondary system can be of the manual nature provided it does not require a substantial amount of manpower or time to accomplish the opening or closing of the door.

PHASE I: Conduct feasibility studies and develop a system design to include details on all major components of the system.

PHASE II: Build and demonstrate a working prototype for validation and verification of the proposed concept. This prototype shall show all components of the system and show the complete operation of opening, closing, and locking of the doors.

PHASE III: Develop a working model, scaled in size to facilitate mounting on the ship motion simulator located at a land based test site for final testing and verification of the system design. An alternative for a Phase III effort is an onboard prototype installation utilizing an in-service ship as a test platform.

COMMERCIAL POTENTIAL: The technology developed here can be widely used in the commercial sector. This could be used on commercial airliner hangar doors, large factory and warehouse doors, and also garage type structures that would have large openings for trains and buses.

REFERENCES:

1. Business Wire"SRI International Receives honors for Novel Magnetic Levitation Technology" 5/30/2000

2. Elevator World "Linear Motor Driven Vertical Transportation System" 9/01/96

3. Insight "New High Speed Trains Fly" 10/2001

4. MIL-S-901D, Shock Requirements

5. MIL-S-167-1, Vibration Requirements

6. MIL-STD-461E, EMI Requirements

KEYWORDS: Linear motion, horizontal movement, intelligent controls, magnetic levitation

N03-040 TITLE: Alternative Drive System For Deck Edge Elevator

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 378: Next Generation Aircraft Carrier

OBJECTIVE: Develop new drive system that will replace existing complex hydraulic engine that is currently used to raise and lower deck edge elevators. The new system shall be designed to replace the existing system, which is made up of several subsystems and components, such as, pumps, piping systems, tanks, electrical components and controllers, hydraulic components, and hazardous hydraulic fluid.

DESCRIPTION: There are four aircraft elevators on an aircraft carrier, which are used for moving aircraft and equipment between the hangar deck and the flight deck. Currently, the system uses a hydraulic ram, through a system of wire ropes and sheaves, to raise and lower the platform and load. The machinery rooms are very large in order to accommodate the large amount of equipment required to move the platform load. The existing aircraft elevator systems are logistically complex utilizing a 300 valve hydraulic system with high-pressure accumulators, four 200HP hydraulic pumps, air flasks, exhaust, storage and sump tanks, cooling pumps, extensive piping and the main hydraulic lift cylinder. Each aircraft elevator requires 3000 gallons of hydraulic fluid for operations and presents the risk of overflow/leakage. The hydraulic fluid used in the system is a phosphate ester based fluid in accordance with MIL-H-19457. It is considered a personnel and environmental hazard and is costly to purchase, store and dispose. These elevators require extensive labor and material to maintain and repair. A reliable, less labor-intensive system is desired.

The desired system shall operate without the use of hydraulics or any other hazardous material/fluid. It shall be required to be able to move loads up to 500,000 pounds in the vertical plane within 20 seconds for a distance of 36 feet. The acceleration and deceleration at the beginning and end of travel shall be gradual to minimize stress of the equipment and loads. It shall require little or no maintenance with a Mean Time between Failure (MTBF) of 10,000 hours. System shall contain intelligent controls that will provide information to an operator's panel to include but not be limited to, system status, troubleshooting information, and maintenance information. System shall, at the very least, maintain the level of safeties of the current system. System shall meet shock, vibration, and EMI requirements in accordance with MIL-S-901D, MIL-S-167-1, and MIL-STD-461E, respectively. If the proposed system consists of multiple actuators, the design shall include proper feedback that shall be incorporated into the control algorithm such that, the algorithm shall ensure that load sharing is accomplished between actuators. Load sharing between multiple actuators will be essential for a reliable system. The design shall also allow for disabling of a failed actuator within the system, such that system can still be operated. It shall also have a secondary method of operation in the event of a total failure of the primary operating system. The secondary system would be permitted to move a smaller load at a slower rate. The new system should significantly reduce the weight of the current system due to the elimination of hydraulics, and the many associated sub-systems and components from the existing drive system.

PHASE I: Conduct feasibility studies and develop a system design that includes details on all major components of the system.

PHASE II: Build and demonstrate a working prototype for validation and verification of proposed concept. This prototype shall show all components of the system and show the complete operation of controlling the operations of the elevator.

PHASE III: Develop and implement an installation plan and conduct a shipboard installation on one elevator for final testing and verification of system design through the Advanced Concept Technology Demonstration (ACTD) program, Office of Naval Research, or PEO Carriers.

COMMERCIAL POTENTIAL: The technology developed here can widely be used in the commercial sector. This could be used on commercial cargo ships for transferring cargo into and out of the holds of the ship. It can also be applied to the civil engineering field of drawbridges and could be utilized in the shipbuilding industry for positioning of large prefab compartments for final positioning and welding.

REFERENCES:

1. Business Wire"SRI International Receives honors for Novel Magnetic Levitation Technology" 5/30/2000

2. Elevator World "Linear Motor Driven Vertical Transportation System" 9/01/96

3. Insight "New High Speed Trains Fly" 10/2001

4. MIL-S-901D, Shock Requirements

5. MIL-S-167-1, Vibration Requirements6) MIL-STD-461E, EMI Requirements

KEYWORDS: Intelligent controls, vertical plane, actuators, control algorithm.

N03-041 TITLE: Acoustic and Electro-Optic Data Fusion

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS-210: AN/AQS-20/X Sonar Mind Detecting

OBJECTIVE: Correlate and fuse data from the Eletro-Optic and acoustic sensors into a single computer-aided system. This would significantly increase mine identification capability by correlating the complementary strengths of both types of sensors.

DESCRIPTION: Electro-optic and acoustic sensors have demonstrated powerful means for mine detection, classification, and identification; and are currently being integrated into the AQS-20A towed mine hunting system. Each sensor has its strengths and complements one another for the various water environments. Acoustic Sensors provide wider coverage and are not affected by water clarity. Electro-Optic Sensors provide high resolution 3-D imaging and are insensitive to density stratification and reverberations. This effort would extract the strongest identifiers from both sensors and fuse the data into a computer-aided capability.

PHASE I: The Phase I activity for fusing the electro-optical and acoustic sensor data will focus on reliable reacquisition of contacts in preparation for identification. In this application, a given Mine-Like Object (MLO) that has been flagged as a contact by the AN/AQS-20A Detection Classification & Localization (DCL) processing and/or Post-Mission Analysis (PMA) is subsequently re-visited for identification by the AN/AQS-20A tow body using both the electro-optic (EO) and acoustic gap filler sensors. The outputs from the processing of these sensors can be fused at two different possible levels to improve the reliability of correctly re-classifying the intended AN/AQS-20A contact as mine-like in preparation for identification:

High-Level Algorithm Fusion: The electro-optic and acoustic image processors each map the location of the contact onto a common coordinate reference frame (termed "co-registration" or "clustering") and then map the contact's measure of mine-likeness onto a normalized "confidence factor" interval, for subsequent fusion of the EO and acoustic outputs into an MLO or non-MLO contact decision. Past studies have shown that this type of "algorithm fusion" has been effective in reducing the classifier false alarm rate when the outputs from two or more algorithms are each derived from the same acoustic sidescan sonar sensor. In these studies, a "Fisher-based" fusion algorithm was shown to be effective in reducing the false alarm rate by a factor of 2. This algorithm generates optimized weights that are then applied to the confidence factors of each algorithm's contacts. The weighted confidence factors for contacts that co-register sufficiently close to each other in distance are then summed and thresholded. The proposed study will determine whether this approach can be extended to algorithm outputs from the two different sensors, in particular the EO and acoustic gap filler sensors.

Lower-Level Feature Fusion: The EO and acoustic post-processing algorithms each generate different feature sets to determine mine-likeness for a given object. In this feature-based fusion study, these different feature sets will be evaluated to determine whether a subset of the acoustic features can be used in conjunction with the EO features (or vice versa) to provide an improved characterization of the object before a classification decision is made. This approach thus essentially aims at deriving an optimal "orthogonal" set of features from the two sensors.

PHASE II: The Phase II activity will extend the results of the Phase I classification benefits to automated identification processing of contacts from the EO sensor.

PHASE III: Implement optimized algorithms in real time computer systems, and provide capability to operational navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Object detection, classification, and identification is required for various ocean surveillance applications, such as pipeline inspection, geophysical exploration, and search and rescue operations. Computer-aided identification would significantly enhance these commercial applications.

KEYWORDS: Sensor Fusion, Mine Countermeasures, Algorithm Fusion, False Alaram Rate

N03-042 TITLE: High Efficiency Mission Performance for Underwater Expendable Countermeasure Devices Commonality Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: Undersea Defensive Warfare Systems Program Office, PMS415D

OBJECTIVE: Development of a high efficiency energy conversion approach to optimize countermeasure power source (battery) for maximum output in terms of acoustic signal, source level, speed, and mission duration. This would apply to applicable components for submarine launched 3-inch countermeasure devices. A single integrated package suitable for integration and common application in these devices is contemplated which may include a combination of the following: high efficiency motor/shaft/propulsor mechanisms, advanced motor technology, electronic noise interference protection, materials improvements (lighter), etc. as well as possible high density power source improvements.

DESCRIPTION: With the enhanced capabilities (such as sustained mobility and adaptive signal generation) of expendable submarine launched countermeasure devices, the availability of the increased mission time of these devices is significant to submarine torpedo defense, mission effectiveness and survivability. The battery capacity of the existing configuration (1.7 Amp/Hr @ 2.75” Diameter x 9.2” Length, 4.8 Lbs) is currently insufficient to adequately provide full mission performance of the enhanced capabilities. The present configuration of mobile 3” countermeasure device requires 4.0 Amp/Hr at 18 amps to support the worst case mission for full duration. The countermeasure device size (3” diameter, 39.5” length), unique shape (tapered ceramic front end, tapered aft end), weight restrictions (13.5 lbs in-air), submarine safety requirements and submarine qualification costs severely restrict modification or development of a new, one-of-a-kind, "high" powered, lightweight, low cost, “throw away” battery for this application. In lieu of a new battery development, the preferred approach for this topic is development of high energy-high efficiency components and subassemblies specifically designed and integrated to optimize the total overall system efficiency in a single integrated package. This is considered to be a more cost effective and feasible means of extending the fixed energy capacity of the existing battery to meet the expanded capability of these new devices.

PHASE I: Develop applicable component and packaging alternatives. Evaluate integrated packaging of high efficiency battery energy conversion system concepts for application to submarine launched 3-inch countermeasure devices. The design concepts must optimize the 3-inch devices' common battery, amplification components, materials, circuitry, etc for maximum mission time performance with lowest cost. Phase I shall result in a single design packaging concept to be prototyped and demonstrated in Phase II.

PHASE II: Complete development of the packaging concept design and fabrication/assembly specifications for prototype build. Fabricate, integrate and demonstrate single integration packages for 3-inch devices. The demonstration shall validate integration effectiveness, performance and cost. The packaging design shall be documented as an engineering change to the existing ADC Mk 2 mobile device.

PHASE III: Phase III shall complete the design production readiness of the engineering change design for 3-inch countermeasure devices.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is significant commercial potential for the high efficiency integrated packaging concept to small land and marine systems under fixed battery (energy) conditions. There is also significant application potential to Navy unmanned underwater/surface vehicles and devices.

KEYWORDS: high efficiency, energy, countermeasures, components, increased run (mission) capability

N03-043 TITLE: High sensitivity, pressure compensated optical hydrophone

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT II: PMS435

OBJECTIVE: Develop an all-optical, pressure compensated hydrophone, that can be used in towed, moored or bottom mounted system applications.

DESCRIPTION: An optical hydrophone that meets submarine survival pressure and improves acoustic sensitivity is needed to meet future sensor performance requirements. An optical, pressure compensated hydrophone has the potential to increase overall system performance, increase reliability and reduce unit and life cycle cost. Candidate sensors must maintain acoustic sensitivity over an operating pressure range of 0 to 3,000 psi and a temperature range of -4 to +45 deg C. Compatibility with current towed array sonar systems requires a maximum diameter of 0.625 inches and a maximum ridged length of 5.1 inches. A nominal sensitivity of -120 dB re 1 radian/micro Pascal is needed to meet system performance requirements.

Current fleet operational systems use piezoelectric hydrophones and an AC coupled preamplifier. Pressure compensated hydrophone advantages are a potential 15 dB sensitivity increase and channel-to-channel match variations, which are critical to subsequent signal processing, will become depth independent. Present optical hydrophones do not provide optimum sensitivity or dynamic range over the full operating pressure range. An optical pressure compensated hydrophone improves sensitivity, dynamic range, accuracy and stability without the need for outboard electronics.

PHASE I: Contractor shall provide a conceptual design for a thin line towed array hydrophone and hydrophone group. Analysis shall be completed to demonstrate compliance with the stated pressure and depth requirements. A prototype shall be constructed to validate the performance prediction.

PHASE II: Contractor shall complete the design, fabricate prototype hardware, and demonstrate operation in a thin line towed array form factor. Twenty-six (26) acoustic channels minimum shall be provided to the Navy. The Navy will integrate the 26 acoustic channels into a towed array module. The Navy will test the hydrophone assembly acoustic properties. The Navy will also test the hydrophone assembly durability on submarine handling systems.

PHASE III: Successful completion of phase II efforts may result in a hydrophone assembly design for transition into the fiber optic thin line towed array project.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector applications include geophysical oil and gas exploration as well as bottom mounted reservoir-monitoring sensors.

KEYWORDS: Fiber optic, acoustic sensors, hydrophone, towed array, pressure compensated, bottom array

N03-044 TITLE: Develop and Evaluate Alternative Hullform Technology for the 11 Meter Ridgid Inflatable Boat

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT IV: PMS EOD

OBJECTIVE: The topic proposes the exploration and the quantification of alternative hullform performance characteristics comparable to the Naval Special Warfare 11M Ridgid Inflatable Boat (RIB) operation and suitability specifications. This S&T effort will study the ride quality, boat signature and apparent "natural" drag reduction of the hullform. Studies will observe surface wake, powering performance, maneuvering, motions, and anti-slamming characteristics of the craft in realistic seas at varying speeds (zero to max), draft, trim and load conditions will be quantified. Additionally, studies will be conducted while performing marine mammal system and diver insertion and extraction scenarios. Research efforts should be oriented at demonstrating the best hull geometries to enable high speed, stable operations in heavy sea states with low visibility characteristics.

DESCRIPTION: Faster boat speeds with shock mitigation and reduced footprint enable Naval Expeditionary forces to more quickly insert personnel, equipment, and marine mammals into position for low observable missions to support strategic and tactical objectives. While on target, efficient low speed operation and minimum motions at loiter speeds enable men and equipment to remain on station and effective in all but the most severe weather environments. The principal difficulty in attaining these objectives from current displacement vessels is overcoming the hull speed limit while maintaining good ride quality in seaway imposed motions at all speeds. Additionally, existing craft in this size range do not address signature reduction for vulnerability/detectability concerns. Research into hull performance improvements combined with signature reductions is an area of great interest for the VSW MCM forces. Long-term potential payoff to the US Navy could include fielding a faster, more efficient and effective combatant craft.

PHASE I: Study the hydrodynamic phenomenon of alternatives to traditional hullforms and their application for the 11M RIB. Compare the results from these studies with equivalent features for existing 11M RIB hull forms. Evaluate current capabilities and limitations for diver/marine mammal insertion and extraction operations. Develop a testing program to quantify performance characteristics of the prototype design for phase III.

PHASE II: Design and construct an operational prototype for evaluation and use by VSW MCM forces.

PHASE III: Carry out engineering testing on the operational prototype.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The resulting data could be available to boat builders for implementation on Navy and commercial boats. Alternative hullform technologies could enable the boating industry to build better boats with improved efficiency and improved performance in adverse conditions.

REFERENCES:

1. William F. Burns III, "M-Hull Technology", Marine Transportation System Research and Technology Conference, November 14-16, 2001.

2. Charles W. Robinson, Society of Naval Architects and Marine Engineers, New York Metropolitan Section, "M-Hull - A Low Wake Design", April 11, 2001.

3. Martha A. R. Bewick, "Ferries in the United States and the International Marine Transit Association". Aquapolis, Quarterly on the International Centre Cities on the Water, Volume 2, Issue 24, June 2000, pp. 13-19.

4. Additional web information: http://www.mangiaonda.com/

KEYWORDS: High-speed, signature reduction, shock mitigation, ride quality, efficient hull, longer range, sea keeping, and station keeping.

N03-045 TITLE: Knowledge Gathering Network for BFMIS

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: This effort will develop an intelligence gathering system to identify and monitor the knowledge gained from the integration of system interoperability management data (Risk analysis, BF Comparisons, Metrics, DMSAR, Program TRs, BF CM data, BF ECM analysis) with mission analysis, system models, requirements, network models, and functional analyses. This effort will also document knowledge management processes that exist or are required for the effective utilization of knowledge resulting from the combination of multiple BF systems. Finally, the effort will identify available implementation methods for expanding the knowledge generation capability of the Navy attributed to the implementation of intelligence gathering and knowledge dissemination networks.

Historically, the collection, storage and use of data in the BF community have been stove-piped and proprietary to programs and units. Significant strides are being made today in the creation of interoperable systems through interfaces, standardized data management practices, and collaborative data-sharing environments. However, it is still very difficult to quantify what knowledge is gained from establishing interoperability among the various monitoring and support systems, what improvements in BF performance are possible, and how the knowledge gained from interoperability can be effectively shared and communicated thorough the community.

The two critical issues now facing the BF community are to define how the information gained from improved interoperability can be easily and quickly analyzed to provide knowledge that enables decision makers to decide where and how improvements can be made; and to determine how the new knowledge can be created or gained in a systematic fashion. Simply stated, the BF community must learn how to replicate the knowledge creation process using other than ad hoc methods.

DESCRIPTION: It is the goal of this project to develop knowledge systems with the ability to analyze data and information, pose questions regarding performance and requirements improvements, and recommend where and how efforts can be made to improve overall performance. These analyses will utilize current and historical data from program offices, system testing, configuration, and certification information. The overall goal is to document and identify the "knowledge" gained from the systems used to support the BF community, and the processes used to disseminate this knowledge.

An XML-based data warehouse will be utilized to serve as the foundation of a knowledge-based system architecture that captures system configuration, certification, operational, and test data along with a description of the organizational groups and processes that utilize this information and data. A feedback mechanism will be defined in order to measure the performance gain experienced by these groups and systems in using the information gathered in the course of system operation. This mechanism will allow the organization to identify which data items and organizational processes are effective in increasing organizational readiness and overall performance.

PHASE I: Define a generalized knowledge architecture including the structure of the data warehouse, interfaces to data sources, operational processes, affected user groups, and responsible organizational entities. Provide technical justifications for managing interfaces, collecting required data, and select data mining and decision support tools. Complete Phase I by delivering a prototype of the XML-based data warehouse, populating it with selected data, and demonstrating the present knowledge creation and dissemination process.

PHASE II: Construct a knowledge management approach and system to sample and retrieve information from the affected programs and units, transmit the data through known organizational processes, or identify channels where data must be transmitted to have the desired impacts on performance. Select appropriate data mining and decision support tools and integrate those tools into a working system. Participate in field-testing and knowledge dissemination meetings.

PHASE III: The objective of Phase III is to develop the initial working system that can work with the legacy data sources, and to the maximum extent possible, with the existing computing and network facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are numerous private sector applications for knowledge-based systems in areas such as environmental data collection and decision-making, large power systems, pipeline transmission systems, power generation and transmission systems, and other large complex and dynamic systems.

REFERENCES:

1. Davenport, T., Prusak, L. (2000). Working Knowledge: How Organizations Manage What They Know. Cambridge, MA: Harvard Business School Press.

2. Nonaka, I., Takeuchi, H. (1995). The Knowledge Creating Company. Oxford: Oxford University Press.

3. Polanyi, M. (1967). The Tacit Dimension. London: Routledge & Kegan Paul.

4. Sveiby, K. (1997). The New Organizational Wealth. San Francisco: Berrett-Koehler Publishers

KEYWORDS: Acquisition and dissemination of knowledge, knowledge management

N03-046 TITLE: Logistics Support Systems using Advanced Multimedia Technologies

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: OPNAV N77, ACAT Level III

OBJECTIVE: Develop a Logistics Support System for Submarine Combat Systems using advanced Multimedia Technologies. Enable developers of technical data (TD)(i.e. Technical Manuals, Preventive Maintenance System) to create data reuse in similar documents. Research and develop an innovative, computer or wireless communications device based integrated technical instruction and training product capable of providing interactive system operation requirements and just in time operation and maintenance training for complex COTS based electronic systems. This product should be able to be easily and inexpensively updated to keep pace with the projected annual system modifications being introduced into today's COTS based systems. This product should also be able to be delivered through individual computer workstations, across local area networks, via wireless devices and be accessible from remote sites in accordance with distance based learning requirements.

DESCRIPTION: Due to the operational nature of submarines, personnel are very reliant on robust and easily understandable training and technical documentation related to shipboard equipments. Navy TD is currently being converted from paper to a structured data format (XML/SGML). This data is being loaded into object oriented databases (DB), Content Management System (CMS). The data is stored in these DBs using the tagging hierarchy to create objects. Once loaded these objects can be reused when building similar documents (write once use many). Currently the only way to establish reuse is by thorough manual examination of each document. This effort would be developing techniques for the comparison of similar documents, and the identification of areas containing data that is identical or some what similar. The product would identify the level of confidence it has in matches that are not identical. Logistics Support must be developed that can be utilized by shipboard personnel with little in the way of offboard support. By using the latest methods and tools of advanced multimedia, these logistics products can better be used to support equipment operators. In recent years, logistics support systems onboard submarines have become more computer based vice paper based. However, recent advances in computing power, dynamic 3-d Modeling and Immersion Technologies have not been employed. Training and Maintenance solutions that offer delivery of dynamic imaging, combined with web based open-imaging platforms can allow operators to improve onboard tasks and speed the understanding of system operation.

System technical documentation has traditionally been a stand-alone paper technical manual, recently migrating to stand-alone Integrated Electronic Technical Manual. Combat System operation and maintenance training has traditionally been supported by procuring a tactical system that is installed at a land based school site. This approach, utilizing separate technical documentation and training products, is impractical for the COTS based electronics systems being procured today because frequent (annual) system design changes are being introduced to implement performance improvements. The expense of upgrading a training asset, combined with the inability to maintain consistency between technical documentation and training, necessitates a change in the logistics products supporting system operation, maintenance, and training. Development of an integrated, computer based technical documentation and training product will ensure up to date support products and significantly reduce product development cost. An acceptable product will be able to teach proper system theory, operation, and troubleshooting techniques while imparting the skills required to maintain a COTS based electronics system.

PHASE I: Develop a system design for an advanced logistics support system that provides state-of-the-art tools designed to enhance onboard training and maintenance. Develop data modeling based on existing structured Navy TD. This analysis should include an understanding of Navy use of the data and establishment of expected constructs for reuse. The level of human interaction should be identified and planned users environment should be designated. This plan should also include integration plans with existing Navy CMS. Provide the specification for the basic capabilities and functionality of this system. Research and develop the technology/process required to produce an integrated technical documentation/training product capable of meeting all objectives identified above. Additionally this training methodology incorporated product/process should train to the technology of the system, not focusing on specific system design, and should be designed such that it can be inexpensively and rapidly revised (if necessary) to support changes to system design.

PHASE II: Develop and test a prototype system, with the capabilities as defined in the Phase I effort. The test will establish level of accuracy and required human interface as well as ease of use. Provide an Application Programmer Interface (API) specification, if necessary. Using the training process developed in Phase I, develop a prototype integrated technical documentation/training product. Demonstrate how this prototype supports a "training to electronic technology" concept and demonstrate the ability and process required to update the product in support system design changes and multiple system configurations.

PHASE III: Deploy the logistics system on a development program and production environment. The contractor would assist in deployment, train users and provide technical support during the initial deployment. Improve performance, reliability and operability as required by this integration effort. Provide documentation and open-standards interfaces to the development community. Develop and field system specific product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied to any government or business to be used for training and maintenance of complex equipments and systems. Computer based equipment operation and training products are being introduced throughout commercial industry. Any integrated product developed under this SBIR topic will be marketable to other military departments and the commercial industry. This system could be applied to any commercial application that is using/developing structured data. This effort reduces ownership costs in the following ways:

1. The approach will lower the data surveillance cost burden for information dependent communities (training, maintenance and operations).

2. The approach will lower the cost of data creation and subsequent management by optimizing data reuse.

REFERENCES:

Existing Systems:

1. Sharable Content Object Reference Model (SCORM). Additional info: www.adlnet.org/index.cfm?fuseaction=scormabt&flashplugin=0.

2. Seamless Product Information, Data Exchange & Repository at www.ott.navy.mil. Topics: Distance Learning, Web Based Training , Educational Technology and Information Technology.

3. Virginia Tech College of Arts and Sciences, Cyber school. www.cyber.vt.edu.

4. Diffing Technology. www.alphaworks.ibm.com/tech/xmldiffmerge.

Performance Requirements:

1. Mil-PRF-29612B, Performance Specification, Training Data Products dtd 31 August 2001.

2. Mil-PRF-87268A, Interactive Electronic Technical: General Content, Style, Format and User-Interaction Electronic Technical Manuals.

3. System Preferences: HTML based language capable of running on a PC based platform.

4. Mil-STD-38784, Standard Practice for Manuals, Technical: General Style and Format Requirements, 02 July, 1995.

5. Projects: (New York University, Center for Advanced Technologies, http://cat.nyu.edu)
   A. Tangible Media
   B. Responsive Workbench
   C. 3D Autostereo Display

KEYWORDS: logistics, 3-D modeling, Immersion Technologies, dynamic imaging, training, reuse, analysis, content, XML

N03-047 TITLE: Low Cost Submarine UAV Communications and Sensor Data Link

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: NAVSEA PMS 435, Non-Acquisition ASSEP Program (currently)

OBJECTIVE: Design, prototype, and test a small submarine Unmanned Aerial Vehicle (UAV) communications and sensor data link. The data link shall be capable of transmitting air vehicle Command and Control (C2) data and Electro Optical/Infared (EO/IR) sensor data out to a range of 50 nm. The data link shall use existing submarine antennas.

DESCRIPTION: The submarine is one of the nation's premier covert intelligence gathering platforms. Advances in unmanned systems, data compression, and miniaturization of RF components have resulted in smaller and more capable UAV data links. This effort will leverage and integrate existing RF component and data link technology to design, prototype, and test a submarine UAV communications and sensor data link. The data link shall use existing submarine antennas and terminals as much as possible. The data link will be installed on a small and expendable submarine launched UAV that will be used for situational awareness and intelligence gathering missions. In addition, the data link can be used to enable communications with other submarine offboard sensors such as Unmanned Undersea Vehicles (UUVs).

PHASE I: Develop a concept, an Analysis of Alternatives (AOA), and a proposed system design for a small submarine UAV communications and sensor data link. The design will be capable of supporting all submarine classes and will include manufacturing cost estimates for the data link. The report will include a data link Analysis of Alternatives that trades weight, performance, size, cost… to provide a decision making tool to support further development of the data link. The US Navy will provide submarine antenna and terminal performance specifications to the contractors in support of this topic.

PHASE II: Prototype and test the Phase I small submarine UAV communications and sensor data link. The contractor will provide the surrogate air vehicle to support the data link testing. The US Navy (Naval Undersea Warfare Center (NUWC) Newport), will provide shore based test support resources for evaluating the performance of the data link. Testing of the data link will not occur on a submarine.

PHASE III: Successful execution of Phase II will result in the communications and sensor data link transitioning to PMS 435 for integration into a submarine launched UAV System. The UAV will be an expendable sensor with limited capabilities designed to support the submarine and not a joint compatible Intelligence, Surveillance, and Reconnaissance (ISR) asset. The UAV System will be used in support of situational awareness and intelligence gathering missions in the littorals.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Small UAVs have surveillance applications in support of police work, border patrol, and physical security. Existing small UAVs have very limited data link ranges and this SBIR topic will develop an extended range data link capability for small UAVs. This SBIR has applicability across all DoD services that are currently evaluating and/or deploying UUVs and small UAVs.

REFERENCES: Office of the Secretary of Defense, UAV Roadmap 2000 - 2025, April 2001.

KEYWORDS: UAV, UUV, communications, antenna, submarine, data link, wireless

N03-048 TITLE: Low Cost Electronics System for Large Sonar Arrays

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I PMS 450 SSN 774 VIRGINIA CLASS SUBMARINE (FORMERLY NSSN)

The Navy is developing very large hull arrays, with channel counts ranging from 1500 to 10,000 or more. Getting the data inboard, processing it, and displaying it in an effective way presents new challenges to the electronics system designer. Innovation and technology efforts have pushed the envelope of inboard signal processing and sensors for submarines and surface ships. However, there are severe choke points for time-synchronized high data rates that aren't addressed by gigabyte ethernet, and there is no application that integrates huge amounts of raw data to create key information for the operators. Two major areas need to be addressed as part of this SBIR. First, large (1 GB/s aggregate or more) data transfer of thousands of time-synchronized channels of information through a submarine hull penetration from copper wire or fiber is needed. Second, integrated operator-machine displays are required that combine multiple parameters such as azimuth, vertical angle, time, range and intensity to present time critical, vital information in a manner that is intuitive to the operator. Packaging, mounting, hull penetration, maintenance, reliability, installation, upgrades, space, weight, and cost should all be considered.

PHASE I: The phase I effort should provide a concept, algorithms and brassboard demonstration of one or both of the needs (data rate and information display).

PHASE II: Detail design and prototype a system that addresses the best value areas associated with development and deployment of very large hull mounted sonar systems, as selected by the government.

PHASE III: Integrate the selected system with new and existing platforms to provide a low cost integrated solution for hull mounted sonars.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Telecommunications, data processing, and information technology sectors will benefit from these developments

KEYWORDS: telemetry, data transfer, information technology, operator-machine interface, integrated display, submarines, sonar, sensors, CAVES

N03-049 TITLE: System Automation That Will Support Reduced Manning On Submarines (Component-Level Distributed Control System Technology)

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: SSN 774 VIRGINIA CLASS SUBMARINE (FORMERLY NSSN)

OBJECTIVE: In order to reduce manning and at the same time maintain the capability and survivability of our submarines a new breed of automations systems must be fielded. This SBIR will focus on the development of advanced automation technologies and systems that will allow crew manning to be reduced on VIRGINIA Class Submarines.

DESCRIPTION: In order to reduce manning and at the same time maintain the capability and survivability of submarines, a new breed of automation systems must be fielded. For the past 5 years, the commercial sector's research and development community has been actively investigating this advanced automation system challenge. One of the cornerstone technologies produced by this effort is component-level distributed control system technology (CLIDICS). CLIDICS systems are comprised of numerous nodes distributed throughout the ship, and connected in a peer-to-peer manner via a device-level control network. Each node is programmed to make intelligent automation decisions - both with and without collaborative information from other nodes - during normal and casualty conditions. It is envisioned that these device-level nodes will form the backbone of advanced shipboard control systems capable of providing an automated damage control response. Specifically, they will be capable of detecting, isolating and reconfiguring themselves, and the systems they control, autonomously after the ship sustains battle damage.

PHASE I: Research which VIRGINIA Class Submarine HM&E systems should/could be automated in support of reducing the crew size. Investigate/develop automation system components embracing component-level intelligent distributed control system approach for use on VIRGINIA Class Submarines. Design candidate automation systems and conduct analyses of candidate automation system components including definition of actuator, sensor, and/or controller specifications, including signal quantity and input/output requirements, sensor accuracy, communication interfaces, noise signature, and component MTBF data. System-level analyses shall be conducted that assess system reliability and survivability, as well as their impact on crew manning. Automation system components must meet or exceed the applicable military specifications and standards for equipment installed on VIRGINIA Class Submarines. Consideration should be given to systems that employ small-foot print CLIDICS devices with innovative, integrated means to attenuate shock and vibration environment.

PHASE II: Design and test prototype CLIDICS-based automation systems selected in Phase I. Demonstrate automation system performance and effectiveness using high-fidelity laboratory platform capable of hardware-in-the-loop demonstration and testing. Evaluation platform should allow for introducing system and automation system casualties, such as actuator or sensor failures, or loss of power, etc. Develop implementation plan to transition selected automation systems to service on VIRGINIA Class Submarines.

PHASE III: Install and test approved automation systems on board designated VIRGINIA Class Submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be applied in any commercial or industrial system requiring survivable automation.

KEYWORDS: Reduced manning, automation, analysis, human, nodes, instruction, CLIDICS

N03-050 TITLE: Innovative and Non-invasive Heat Load Removal of Electronic Components/Computers

TECHNOLOGY AREAS: Ground/Sea Vehicles, Space Platforms

ACQUISITION PROGRAM:

OBJECTIVE: Develop technologies that will enhance the operational efficiencies of COTS electronic components/computers in a high temperature environment and reduce the subsequent heat load of their operation. A system that will not consume power and produce zero noise is of particular interest.

DESCRIPTION: Due to significant costs savings, combat and weapon systems are moving to using Commercial-Off-The-Shelf (COTS) technology both at the component and system level. These COTS systems are only spec to operate at ~1050F-1150F. Unfortunately, many of these combat/weapon systems are being required to operate in warmer environments than originally planned. In addition, the density and complexity of electronic components and systems have resulted in the concentration of heat loads into a more compact densely populated component area. Difficulties in removing the concentration of heat have resulted in higher operating temperatures of electronic components and in the spaces onboard Navy combatants. These two factors are especially problematic in the confines of submarines. In addition per Submarine Type Commanders (TYCOMs) direction, all references to operating conditions shall use sea water injection temperature of 970F. This increase in sea water operating temperature from 850F to 970F is a recent change to TYCOMs requirements.

Heat pipe technology has been demonstrated as a successful means of heat management for satellites. This technology is of particular to the submarine force. The development of a mini-loop heat pipe for shipboard use would allow heat management using existing chilled water source or open sea as a heat sink thus eliminating unwanted power consumption and noise generation.

PHASE I: Research current design of COTS electronic components and systems onboard submarines that are experiencing thermal operational problems. Research and identify technical and affordable alternatives (e.g., a mini-loop heat pipe that would interface with shipboard chilled water system for electronic consoles and open sea for enclosed electronic canisters) for reducing the heat loads and for dissipating the heat in the electronic equipment as well as in the operating submarine. Design must include material selection that is compatible for submarine use.

PHASE II: Design and test a prototype that will demonstrate heat reductions and cooling efficiencies with the least impact to COTS electronics/computers. Develop test plans, procedures and conduct thermodynamic testing; and evaluate implementation costs respective to the Government and contractor approved alternatives. The design should be easily implemented as a field change to the respective electronics equipment, and standardized for use on all classes of submarines and surface ships.

PHASE III: Install and test the Government approved system on board a designated SSN 688 Class submarine.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This effort is directly applicable to any commercial operation where COTS components and systems are being used in marginal thermal operational environments.

REFERENCES: Current magazine article, textbooks on thermal analysis and conductivity, quality control methods and procedures.

KEYWORDS: Thermal reduction; thermal management; heat pipe; heat dissipation

N03-051 TITLE: <u>Low Cost Non-Explosive Shock Qualification Testing</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: Develop innovative and low cost, environmentally safe underwater explosion (UNDEX) shock testing methods suitable for shock testing the ship or shock qualifying major shipboard systems. These methods should employ non-explosive energy sources capable of inducing equivalent shipboard responses as those associated with the traditional early time shockwave, bulk cavitation closure and late-time bubble and flow effects. The specified energy source must be easily deployed to at sea or land-based (dry dock) locations for ship testing, or existing UNDEX test facilities for major system testing. Testing methods should be environmentally friendly and allow for rapid conducting of tests with the ability to replicate multiple UNDEX attack scenarios.

DESCRIPTION: The current methods for at sea full ship shock trials involve the use of extremely large explosive charges. The uses of large explosives in the open ocean is accompanied by several environmental concerns and operational hazards, all of which drive up testing cost by requiring extensive pre-test planning and preparation. Several support craft are required for the extensive and costly process of monitoring marine life, handling the charge and other operational details. Despite these impediments the United States Navy continues to necessitate the shock testing of all first of class ships and significant class deviates. Thus it is desirable to identify a low cost, environmentally safe, alternative means of performing this task. While system testing in quarries using explosive charges currently does not represent a big environmental challenge, significant cost savings may be realized through the use of a device that can be rapidly set-up and "fired". A traditional UNDEX attack induces a complex dynamic ship response that results from several different loading mechanisms. The prominent loading events are the initial shockwave and ensuing bubble pulses. Secondary loadings include bulk and local cavitation closure, reflected pulses from near by boundaries, and flow effects. The significance of these various loading mechanisms vary greatly depending on the attack geometry. Testing methods that employ non-explosive energy sources have the potential to offer a viable alternative to conventional testing. Candidates are requested to develop a low cost environmentally friendly non-explosive testing method capable of replicating the dynamic response induced by the complex loading mechanisms present in a UNDEX test for a variety of attack scenarios. This testing method must be capable of rapid deployment both at sea and in test ponds, for testing ships and other shock test vehicles.

PHASE I: Identify a non-explosive energy source that can be used for testing. Characterize dynamic environments induced by traditional UNDEX testing. Characterization should include conventional full ship shock trials, large charge planar waves, and also small charges in close for whipping tests for small and large ships. Also examine motions induced during heavyweight barge testing (FSP, EFSP, and LFSP) and submersible testing (A/B-1, SSTV, etc.) Perform studies to develop testing arrays that will lead to the desired UNDEX environments, and evaluate the ability of these arrays to replicate the dynamic responses associated with this range of dynamic response environments through conduct of numerical simulations and simple laboratory tests. Specify testing methods, testing configurations and operational procedures. Indicate fiscal and environmental advantages of the alternative testing method.

PHASE II: Demonstrate on a large scale, such as with an LFSP test, the capability of the non-explosive energy source to replicate motions induced by a variety of attacks, including MIL-S-901D related environments. Exhibit rapid setup and ease of operation. Compare measured accelerations, velocities, displacements and frequency response with data from tests using explosive charges. Evaluate the overall performance of the new testing method and cite cost and environmental benefits. Provide test procedure and guidance for conducting non-explosive testing using the alternative energy source.

PHASE III: Perform full-scale demonstrations of non-explosive testing methods against an actual ship at sea or in dry dock. Identify environmental and safety benefits of testing methods. Perform tests replicating both small charges in close and large charge-simulated nuclear attacks. Compare measured accelerations, velocities, displacements and frequency response with data from actual full-scale shock trials using explosive charges. Evaluate overall performance of alternative testing method on full scale.

COMMERCIAL POTENTIAL: A non-explosive shock testing device can be used by the commercial shipbuilding industry to demonstrate compliance with commercial standards for shock and impact loading. This would provide the ability to screen design risks related to dynamic loads encountered due to wave slamming, sea keeping, grounding, docking loads and collisions at sea.

REFERENCES:

1. OPNAV Instruction on First of Class Shock Trials

2. "Shipboard Shock and Navy Devices for its Simulation", NRL Report 7396

3. Gordon J., An Evaluation Of Shock Curtain Design For Nuclear Shock Wave Simulation, SD 78-2

4. Thomsen J., Simulation Of Nuclear Underwater Shock Waves Using Planar Sources: Small-Scale Simulator Testing (The Shock Block Program), I PIC 1546.

5. Florence A., Romander C, Evaluation Of The Shock Block Technique For Generating Underwater Plane Waves, I SRI 6383

KEYWORDS: Shock: Non-explosive: UNDEX: Environmental: Testing: Energy

N03-052 TITLE: Air Blast & Ballistic Impact Damage Evaluation of Marine Composite Structures

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: To develop analytical and experimental methodologies to characterize the deformation and damage of marine composite structures subjected to conventional weapon external and internal blast and ballistic loading. Such a methodology can be effectively used to evaluate and or optimize the design of composite structures with significantly improved survivability under various blast and ballistic threats.

DESCRIPTION: Advanced fiber-reinforced composite materials such as graphite/epoxy and fiberglass/vinyl ester are now being widely used in and considered for construction of naval vessel structures. Enhancing resistance to high-energy blast loading has become a priority to ensure the survivability of composite structures. To date very little research has been conducted in the area of predicting the dynamic response of composite ship structures to conventional weapon blast loading or combined blast & ballistic loading; therefore a technology gap exists. Analytical models that integrate dynamic analysis, failure analysis and material models appropriate for use with composites under high-energy blast conditions are required so that designs can be evaluated for survivability, and design enhancements can be created.

PHASE I: Develop an efficient, dynamic analysis methodology for evaluating and designing composite structures with enhanced blast/ballistic damage tolerance. The Phase I work should verify the ability of the analysis approach to identify the type and extent of damage and the associated energy absorption in composite structural components including structural connections. Innovative material/structural element models (e.g. for sandwich construction panels, stiffened sandwich panels, and structural connections) which efficiently capture composite structural failure modes and dynamic damage propagation for composite structures subjected to fragment impact and/or blast loading are required. These models will be evaluated or developed during this phase. Test requirements needed to support the material models will be specified. The government will provide generic pressure/time history load input and generic composite damage data. Feasibility of approach will be based on quick turnaround capability, application for a wide range of explosive charge sizes and standoff geometry, ability to capture the structural response to the loading and ability to identify the structural failure mechanisms.

PHASE II: Develop an integrated methodology that incorporates blast loading predictions with the composite damage analysis. The resulting analytical tools will be used by the developer to design composite modules resistant to the blast effects of a specified explosive charge size/standoff geometry condition for model verification. Experimental work will be conducted in the Phase II studies including (1) performing material testing to determine the proper material parameters under the blast environment, and (2) fabricating the designed composite modules and conducting blast testing for verifying the predicted damage and blast resistance capability. The structure blast testing will be conducted by the performer with input provided by the government as requested. Structural performance shall be compared to predictions. Completion of verification and validation in Phase II will require access to classified data. The successful offeror will be required to obtain appropriate security clearances for work in Phase II.

PHASE III: Transition the technology to the DDX Program, Shipbuilding Design Offices, and NAVSEA for potential inclusion into Vulnerability Models.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This program will develop a design tool that has direct insertion potential for Defense contractors for survivability design of various composite structures. This is also applicable to commercial shipbuilding and marine craft.

REFERENCES:

1. References of appropriate confidential reports and data will be forwarded upon request and upon confirmation of appropriate clearance in Phase II.

2. Critchfield, M. O. and Judy, T. D., "Low-Cost Design and Fabrication of Composite Ship Structures," Marine Structures, 7, p. 475-494, 1994.

KEYWORDS: blast damage, composite, dynamic analysis, energy absorption

N03-053 TITLE: Waste Heat Conversion Techniques for Power Electronics

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: This topic addresses the development of Waste Heat Conversion technologies to utilize waste heat from both future power electronics and high energy weapon systems on future Naval vessels. Active and passive technologies, phase change, and other heat transfer mechanisms in the conversion of waste heat to useful energy (e.g. cooling, energy storage) are considered the best areas for technology development for generating the payoff that meets future Naval requirements.

DESCRIPTION: The overall strategy is to improve collection to heat sinks, which are the focus of two other Thermal Management SBIR topics, and to convert waste heat to useful energy. This topic will focus on the latter stage. The Navy has committed to using an Integrated Power System (IPS) for future naval vessels. The insertion of IPS will produce heat loads far beyond those in today's shipboard systems. The introduction of additional high power systems such as electromagnetic weapons (EMW) and high power radar, together with the heat loads associated with IPS, will produce heat loads in working spaces approximately 700% greater than those of DDG 51 class ships. A waste heat conversion system must be developed prior to the insertion of these systems that not only supports the increased survivability inherent in IPS but also contributes to lower total ownership costs. The challenge is to develop innovative systems that will utilize the heat collected from IPS power modules and the EMW in a manner that supports a reduced cost of ownership. The waste heat must be collected and converted to useful energy. Advances in the technology to reuse waste heat will significantly increase the overall efficiency and reliability of the All Electric Ship.

PHASE I: Conduct a feasibility assessment of the proposed solution to dissipate waste heat from power electronics cabinets and convert the waste heat to energy for space cooling on Navy ships. The proposed solution must not add waste heat to the workspace that won't be dissipated by the technology solution. Provide design specifications and cost analysis for fleet insertion.

PHASE II: Fabricate and test a prototype Thermal Management system as defined in Phase I. Testing shall verify acceptable cooling capability and the system designers should also be cognizant of requirements of MIL-S-901, MIL-STD-810, MIL-STD-461 and MIL-STD-1310. Develop an insertion strategy for the DD(X) Engineering Development Models (EDM) and the Land Based Engineering Site (LBES) at NSWC Philadelphia by involving the DD(X) awardees and PMS 500 early on in the Phase II process. A commercialization strategy will be developed targeting the power electronics and computer industry.

PHASE III: Produce a full-scale Thermal Management system in conjunction with a Phase III partner for installation and test either in the DD(X) land based EDM, ship based EDM or at LBES in accordance with the insertion strategy developed during Phase II. Testing shall also consist of testing in accordance with MIL-S-901, MIL-STD-461, MIL-STD-810, and MIL-STD-1310.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Industries that will benefit from the application of the technologies developed include PC and Laptop Development, energy providers, automobile, and commercial aircraft.

REFERENCES:

1. Avijit Bhunia, "Thermal Modeling for R-PEBB - Air & Advanced Cooling Techniques", Rockwell Science Center Semi-Annual Project Review, 6 June 2001.

2. Mark Zerby, Kevin King, Martin Quinones, "Thermal Management Concepts for Configurable Zonal Systems Power Conversion Modules", NSWCCD Technical Report TR-82-2000-25, November 2000.

3. MIL-S-901D, "Shock Tests - High Impact (HI) Shipboard Machinery, Equipment and Systems Requirements", 17 March 1989.

4. MIL-STD-1310G, "Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety", 28 June 1996.

5. MIL-STD-461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment", 20 August 1999.

6. MIL-STD-810F, "Environmental Engineering Considerations and Laboratory Tests", 01 November 2000.

KEYWORDS: Cooling; Electronics; Waste Heat Flux; Energy Conversion

N03-054 TITLE: Nanocrystalline Materials to improve Thermoconductivity of Heat Pipes

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Weapons

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: This topic addresses the development of Nanocrystalline Materials to improve the thermoconductivity of heat pipe material for waste heat removal from both future power and high energy weapon systems on future Naval vessels. This topic concentrates on the removal of waste heat from power modules and weapons by means of conduction for transfer to secondary cooling systems for movement of waste heat out to sea.

DESCRIPTION: Improving the thermal conductivity of heat pipes is considered to be the best approach to meet near-term Naval requirements to develop an Integrated Power System (IPS) for future naval vessels. The heat pipe is a thermal device that efficiently transports thermal energy. A heat pipe is an enclosed structure with an internal working fluid. Wicked heat pipes are also insensitive to gravitational fields and motion. Heat pipes are silent, contain no mechanical parts, and are very reliable. Recent advances in Nanotechnology have provided dramatic improvement in properties of existing materials that can lead to improved heat pipe performance.

The solid state power conversion inherent in IPS produces heat loads beyond those in today's shipboard electrical distribution systems. The introduction of additional high power systems such as electromagnetic weapons (EMW) and high power radar, together with the heat loads associated with IPS, will produce heat loads in working spaces approximately 700% greater than those of DDG 51 class ships. In large part, the waste heat is generated in the power semiconductors contained in the power electronics components whose power densities will eventually surpass 1000 W/cm2. Existing technologies are limited to cooling heat fluxes of approximately 100 W/cm2. Technologies for near term ships with cooling capabilities of 300 W/cm2 are the goal of this effort.

PHASE I: Propose a heat pipe material system and determine the feasibility of a system to keep the semiconductor's junction temperature below 125° C., using existing nanocrystals, while removing heat fluxes of at least 300 W/cm2. Provide design specifications and cost analysis for fleet insertion.

PHASE II: Fabricate and test a prototype Thermal Management system using heat pipes as defined in Phase I. Testing shall verify acceptable cooling capability and the system designers should also be cognizant of requirements of MIL-S-901, MIL-STD-810, MIL-STD-461 and MIL-STD-1310. Develop an insertion strategy for the DD(X) Engineering Development Models (EDM) and the Land Based Engineering Site (LBES) at NSWC Philadelphia by involving the DD(X) awardees and PMS 500 early on in Phase II. A commercialization strategy will be developed targeting the power electronics and computer industry.

PHASE III: Produce a full-scale Thermal Management system, incorporating lessons learned from Phase II, in conjunction with a Phase III partner for installation and test either in the DD(X) land based EDM, ship based EDM or at LBES. Testing shall also consist of testing in accordance with MIL-STD-901, MIL-STD-461, MIL-STD-810, and MIL-STD-1310.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Industries that will benefit from the application of the technologies developed include PC and Laptop development, energy providers, automobile, and commercial aircraft.

REFERENCES:

1. Avijit Bhunia, "Thermal Modeling for R-PEBB - Air & Advanced Cooling Techniques", Rockwell Science Center Semi-Annual Project Review, 6 June 2001.

2. Mark Zerby, Kevin King, Martin Quinones, "Thermal Management Concepts for Configurable Zonal Systems Power Conversion Modules", NSWCCD Technical Report TR-82-2000-25, November 2000.

3. MIL-S-901D, "Shock Tests - High Impact (HI) Shipboard Machinery, Equipment and Systems Requirements", 17 March 1989.

4. MIL-STD-1310G, "Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety", 28 June 1996.

5. MIL-STD-461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment", 20 August 1999.

6. MIL-STD-810F, "Environmental Engineering Considerations and Laboratory Tests", 01 November 2000.

KEYWORDS: Cooling; Electronics; Heat Flux; Materials; Thermal Management; Power Conversion

N03-055 TITLE: Advanced Thermal Management for High Heat Flux Power Electronic Modules

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: This topic addresses the development of Advanced Thermal Management technologies, utilizing active phase change materials to induce a physical change of state (e.g. fluid to vapor) that will enable the removal of heat flux at a much higher capability than that of existing technologies. Advancement in high heat flux thermal management technology and their successful integration into future Navy ships are imperative to meet the long-term requirements of future power electronic systems.

DESCRIPTION: The Navy's vision for future warships is feasible primarily due to advancements in power electronics that enable technologies such as the Integrated Power System (IPS), electromagnetic weapons (EMW), high power radar and others. The solid state power conversion inherent in these new technologies produce heat loads in excess of those in today's shipboard electrical systems. As the Navy's vision becomes fully implemented, the population of solid state power conversion devices will increase, and since warships are space-limited, the power density of these devices will experience a comparable increase. The power density of the heat generating losses in these devices will eventually surpass 1000 W/cm2. Existing technologies are limited to cooling heat fluxes of approximately 100 W/cm2. The goal of this effort is to develop technologies for the intermediate and long-term future, with cooling capabilities of 1000 W/cm2. The waste heat collected must be easily rejected to ambient in a manner that supports zonal system survivability.

PHASE I: Propose advanced thermal management techniques to remove waste heat from power semiconductor die for a heat flux of 1000 watts/cm2. The proposed solution must be able to keep the semiconductor's junction temperature below 125 degrees C. Provide design specifications and cost analysis for Phase II prototyping.

PHASE II: Fabricate and test a 250KW prototype power module using the Thermal Management system as defined in PHASE I. Testing of this power module shall verify acceptable cooling capability and the system designers shall be cognizant of the requirements of MIL-S-901, MIL-STD-810, MIL-STD-461 and MIL-STD-1310. The solution must show that the removed waste heat from the power electronic module components will easily interface to zonal heat exchangers for rejection to ambient environments on Navy ships. Develop an insertion strategy for the DD(X) Engineering Development Models (EDM) and the Land Based Engineering Site (LBES) at NSWC Philadelphia by involving the DD(X) awardees and PMS 500 early on in Phase II. A commercialization strategy will be developed targeting the power electronics and computer industry.

PHASE III: Produce a full-scale Thermal Management system, incorporating lessons learned from Phase II, in conjunction with a Phase III partner for installation and test either in the DD(X) land based EDM, ship based EDM or at LBES. Testing shall also consist of testing in accordance with MIL-S-901, MIL-STD-461, MIL-STD-810, and MIL-STD-1310.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Industry will benefit from the application of the technologies developed. The development of high power density thermal management capabilities will result in the savings of several design and development generations for use in commercial and industrial power converters such as fuel cell generation plants.

REFERENCES:

1. Mark Zerby, Kevin King, Martin Quinones, "Thermal Management Concepts for Configurable Zonal Systems Power Conversion Modules", NSWCCD Technical Report TR-82-2000-25, November 2000.

2. MIL-S-901D, "Shock Tests - High Impact (HI) Shipboard Machinery, Equipment and Systems Requirements", 17 March 1989.

3. MIL-STD-1310G, "Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety", 28 June 1996.
4. MIL-STD-461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment", 20 August 1999.17. MIL-STD-810F, "Environmental

KEYWORDS: Active cooling; Electronics; High Heat Flux; Waste heat; Energy Efficient

N03-056 TITLE: Robust Open Systems Architecture Surface and Underwater Vehicles Stern Launch/Recovery System

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Human Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: Develop and demonstrate an innovative system for automated stern launch and recovery of multiple manned and unmanned surface vehicles (USVs) and manned and unmanned underwater vehicles (UUVs) of different types and sizes from a small Navy ship at higher ship speeds (over 10 knots) in a variety of sea states (i.e. up to SS 4-5).

DESCRIPTION: It is projected that the military in general and Navy surface combatants and small ships in particular will employ growing numbers of unmanned autonomous vehicles and small manned craft in the future to perform a variety of functions. In particular, the Navy desires to operate a variety of small boats, USVs, manned underwater vehicles, and UUVs from surface combatants and small ships, necessitating their launch and recovery from their host ships. One launch and recovery area of particular interest, because of its hydrodynamic characteristics, is a ship's stern, which represents key ship space for multiple functions including aviation, steering control and towed arrays.

Currently, systems for handling and stowage and launch and recovery for organic offboard vehicles (OOVs) such as USVs and UUVs are separate, distinct systems. To reduce the demands on Navy ships, it is desired to have common, open systems architecture approaches for these interfaces to permit the handling of multiple offboard vehicles, including current and projected future systems.

In addition, future ships such as the DD(X), CG(X) and LCS, designed for reduced/optimized manning, will not have the luxury of accommodating systems with extensive manning impacts. Proposed systems for shipboard use must be unmanned or minimally manned to reduce workload and personnel exposure to dangerous environments.

This proposal seeks innovative approaches and solutions for stern launch and recovery of multiple organic offboard vehicles of different types and sizes from a small Navy ship. The system must be capable of launching and recovering manned and unmanned small boats and USVs, manned and unmanned USVs, (all self-powered vehicles) at ship speeds over 10 knots up to SS 5. This system must have low acquisition and lifecycle costs, be mechanically simple, and require minimal impact on the offboard vehicles for recovery so as to preserve their performance and certification. The system must also be capable of long-lived operation in the harsh Navy unique environment including requirements for shock and vibration and must be capable of use on multiple Navy ships. Consideration must be given to innovative controls, materials, and mechanical designs.

Vehicles for launch and recovery will range from, but are not necessarily limited to, 10 ft. to 36 ft in length, 21 inches to 12 ft in width, and 200 to 22,000 lbs. in weight. Enabling adapters may be used to accommodate projected vehicle sizes and shapes. Candidate host ships may include monohulls or multihulls. It is desired that the proposed solution not project through the transom or at least be able to be withdrawn completely within the host ship when not in use as to present a low radar cross section. The system must not require personnel to enter the water. Ship's course may be optimized for sea state conditions. The system may incorporate, but is not limited to, devices such as: ramps, davits, A-frames, cranes, "cocoons", baskets, hooks and other capture devices, or combinations thereof.

PHASE I: Develop a feasible, innovative, automated concept for stern launch and recovery of multiple manned and unmanned surface vehicles (USVs) and manned and unmanned underwater vehicles (UUVs) of different types and sizes from a small Navy ship at high ship speeds in a variety of sea states. Develop a concept of operations and projected capabilities, concept descriptions, drawings, operating sequences and projected ranges/limits, weight breakdown and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE II: Fabricate and demonstrate a prototype of the system developed in Phase I. Demonstrate the operation of the system in recovering and securing at least two types of USVs and UUVs relevant to the Navy in land-based testing. Demonstrate operation in a variety of scenarios simulating shipboard conditions. Develop refined concept of operations and projected capabilities, prototype descriptions, drawings, operating sequence and ranges/limits, weight breakdown and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE III: Conduct shipboard testing to evaluate performance in the Navy unique environment and develop plans for shipboard certification and application. Develop detailed concept of operations and projected capabilities, detailed drawings and specifications, operating sequence and ranges/limits, weight breakdown and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements. Develop transition plans for the shipboard, joint services, and commercial uses of the system developed in Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private industry and, in particular, the petroleum drilling and exploration sector, plus ocean research, survey and mining firms will benefit from development of improved means to launch and recover autonomous vehicles in higher sea states from host ships.

REFERENCES:

1. UUV Master Plan: A Vision for Navy Development, Barbara Fletcher, SPAWAR
http://www.spawar.navy.mil/robots/pubs/oceans2000b.pdf

2. Navy Training System Plan for the Mk 30 Mod 2 Training Target System, N88-NTSP-A-50-99-05/D, April 1999,

KEYWORDS: unmanned surface vehicle (USV), unmanned underwater vehicle (UUV), ship interface, launch, recover, small boat

N03-057 TITLE: Automated Open Systems Architecture Shipboard Handling and Stowage System for Organic Offboard Vehicles

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes, Human Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X),

OBJECTIVE: Develop and demonstrate an automated system for shipboard handling and stowage of multiple organic offboard vehicles of different types and sizes on small deck Navy ships with minimal ship impact at higher ship speeds in a variety of sea states (i.e. SS up to 4-5).

DESCRIPTION: It is projected that the military in general and Navy surface combatants and small deck ships in particular will employ growing numbers of unmanned autonomous vehicles in the future to perform a variety of functions. Numerous efforts are underway for the development of organic offboard vehicles (OOVs), including unmanned surface vehicles (USVs), unmanned underwater vehicles (UUVs), and unmanned aerial vehicles (UAVs). Efforts are also underway to develop approaches to improve the ship launch and recovery of OOVs. However, presently the stowage and shipboard handling of these systems is a largely manual task requiring ship's force action and disparate pieces of equipment. With future Navy ships such as the DD(X), CG(X) and LCS designed for reduced/optimized manning, this presents unique challenges for the efficient exploitation of offboard vehicles. Proposed systems for shipboard use must be unmanned or minimally manned to reduce workload and personnel exposure to dangerous environments.

This proposal will develop an innovative, automated robotic system for the shipboard handling and stowage of future organic offboard vehicles. The system must provide for the automated location, retrieval, positive securing, horizontal and vertical movement/reconfiguration, and delivery of OOVs from internal stowage to external launching positions. The system must have low acquisition and lifecycle costs, be mechanically simple, and provide for safe handling and stowage operation in a variety of shipboard conditions especially including high speed and sea states. The system must require minimal impact on the OOVs for handling and stowage so as to preserve OOV performance and certification and promote use with multiple and varied OOVs. The system must also be capable of long-lived operation in the harsh Navy unique environment including requirements for shock and vibration and must be capable of use on multiple Navy ships. The system must present minimal impacts to the ship, especially as related to the external launching positions, which generally represents highly desirable locations with multiple functions. The recovery system shall be developed so as to present minimal hull protrusions. System operation must result in minimum risk to the OOV, ship, or shipboard personnel. Consideration must be given to innovative controls, materials, and mechanical designs.

Innovative development will permit multiple use of the automated system for shipboard functions other than OOV handling and stowage, including but not limited to weapon handling, manned aircraft handling, material transfer, OOV launch, etc, is encouraged. As this effort is targeted at future OOVs that are projected to be smaller and more autonomous than current OOVs (especially many UUVs), ability to accommodate OOVs below an upper size limit of 12 meters in length is suggested. The Navy can provide guidance on OOVs of specific interest and relevance.

PHASE I: Develop a feasible, innovative, automated robotic system concept for safely handling and stowing organic offboard vehicles (OOVs), including unmanned surface vehicles (USVs), unmanned underwater vehicles (UUVs), and unmanned aerial vehicles (UAVs) of different types and sizes on small deck Navy ships with minimal ship impact. Develop a concept of operations and projected capabilities, concept descriptions, drawings, operating sequences and ranges/limits, weight breakdown and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE II: Fabricate and demonstrate a prototype of the system developed in Phase I. Demonstrate the operation of the system in handling and stowing at least two organic offboard vehicles (OOVs) of relevance to the Navy in land-based testing. Demonstrate operation in a variety of scenarios simulating shipboard conditions. Develop refined concept of operations and projected capabilities, prototype descriptions, drawings, operating sequences and ranges/limits, weight breakdown and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements

PHASE III: Conduct shipboard testing to evaluate performance in the Navy environment and develop plans for shipboard certification and application. Develop concept of operations and detailed capabilities, detailed drawings and specifications, operating sequences and ranges/limits, weight breakdown and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements. Develop transition plans for the shipboard, joint services, and commercial uses of the system developed in Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: An automated robotic handling and stowage system such as developed in this effort will have commercial potential for numerous uses including Navy supply ship cargo handling, automated land-based stowage, mail sorting, commercial shipping, baggage handling, automated at sea package conveying, etc.

REFERENCES:

1. Shepard's Unmanned Vehicles Handbook 2002, The Shepard Press, Bucks, UK, 2002.

2. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.

3. UUV Master Plan: A Vision for Navy Development, Barbara Fletcher, SPAWAR, http://www.spawar.navy.mil/robots/pubs/oceans2000b.pdf

KEYWORDS: robotics, unmanned surface vehicle (USV), unmanned underwater vehicle (UUV), unmanned aerial vehicle (UAV), automated storage and handling, ship integration

N03-058 TITLE: Advanced Ship/Fixed-wing UAV Recovery Interface

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Human Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: Develop and demonstrate a lightweight, inexpensive, automated ship system for safely recovering and securing multiple types of fixed-wing unmanned aerial vehicles (UAVs) on small deck Navy ships with minimal ship design impact at higher ship speeds in a variety of sea states (i.e. SS up to 4-5).

DESCRIPTION: It is projected that the military in general and Navy surface combatants and small deck ships in particular will employ growing numbers of unmanned autonomous vehicles in the future to perform a variety of functions. The majority of existing and projected future Unmanned Aerial Vehicles (UAVs) are fixed-wing airframes with no capability for vertical launch and recovery. There are currently no safe and accurate methods for recovery of fixed-wing UAVs aboard ship given the small size of Navy surface combatants and small deck ships. Past systems (Pioneer) that relied on operator skill to target capture nets proved to be less accurate and reliable, resulting in airframe damage and potential personnel injury and ship structural damage. To counter this disadvantage, the Navy is investing significantly in the development of either vertical take-off UAVs or disposable UAVs.

In addition, future ships such as the DD(X), CG(X) and LCS, designed for reduced/optimized manning, will not have the luxury of accommodating systems with extensive manning impacts. Proposed systems for shipboard use must be unmanned or minimally manned to reduce workload and personnel exposure to dangerous flight deck environments.

This proposed system shall provide an innovative approach to recover and positively secure multiple types of fixed-wing UAVs for Navy surface combatant and small deck ship use. This system will enable Navy small deck ships to exploit the large array of fixed-wing, non-vertical takeoff UAVs, and make available to the Navy multiple assets not previously used on ships increasing power projection and surveillance capabilities. The proposed system shall automatically and accurately recover UAVs into an innovative capture device/system with minimum risk to the airframe, ship, or shipboard personnel. Upon completion of a recovery, the system shall be either automatically or with minimal manpower removed or stowed. Consideration must be given to innovative controls, materials, and mechanical designs.

This system must have low acquisition and lifecycle costs, be mechanically simple, and provide for safe ship operation in a variety of shipboard conditions including high ship speeds and up to Sea States (SS) 5. The system must require minimal redesign impact on the UAVs to preserve UAV performance and certification and promote use with multiple and varied UAVs. The system must also be capable of operation in the harsh Navy unique environment including requirements for shock and vibration and must be capable of use on multiple Navy ships.

PHASE I: Develop a feasible, innovative, lightweight, low cost, automated system concept for safely recovering and securing multiple types of fixed-wing unmanned aerial vehicles (UAVs) on Navy surface combatants with minimal ship design impact. Develop a concept of operations and projected capabilities (applicable UAVs), concept descriptions, drawings, operating sequences and limits, weight and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE II: Fabricate and demonstrate a prototype of the system developed in Phase I. Demonstrate the operation of the system in recovering and securing at least two types of fixed-wing UAVs of relevance to the Navy in land-based testing. Demonstrate operation in a variety of scenarios simulating shipboard conditions. Develop refined concept of operations and projected capabilities, prototype descriptions, drawings, operating sequences and limits, weight and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE III: Conduct shipboard testing to evaluate performance in the Navy environment and develop plans for shipboard certification and application. Develop concept of operations and detailed capabilities, detailed drawings and specifications, operating sequences and limits, weight and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements. Develop transition plans for the shipboard, joint services, and commercial uses of the system developed in Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Ease of access to remote, constrained, or unprepared terrain has driven designers to develop vertical take-off and landing systems such as tilt-wing and rotary-wing systems for UAV use. The successful deployment of this system will permit increased use of fixed-wing assets in locations not previously exploited. Multiple service (USCG, USMC, US Army), commercial ships, off-shore oil platforms, weather service, and survey firms could use such a recovery system for similar purposes as those of the Navy.

REFERENCES:

1. Installation Design Requirements (IDR) for Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle VTUAV, 29 September 2000.

2. Navy Training System Plan for the Vertical Takeoff and Landing Unmanned Tactical Aerial Vehicle, N75-NTSP-A-50-0004/D, June 2001, http://www.avtechtra.navy.mil/pdf/VTUAV-D.PDF

3. Draft Navy Training System Plan for the Pioneer Unmanned Aerial Vehicle System, N88-NTSP-A-50-8266D/D, August 1999, http://www.avtechtra.navy.mil/pdf/UAV.PDF

4. Naval Air Systems Command PMA-263 Unmanned Aerial Vehicles website, http://uav.navair.navy.mil/home2.htm

KEYWORDS: Fixed-Wing, Unmanned Aerial Vehicle (UAV), Launch, Recovery, Ship interface

N03-059 TITLE: Ship Motion Effects on Human Performance

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: To establish human performance-based ship design specifications/guidelines for ship hull and on-board equipment (that is, placement of human-operated equipment) that prevent or limit ship motion profiles that adversely affect acceptable human (both individual and team) performance.

DESCRIPTION: As the Navy considers a wide variety of new hull forms for its future ships and missions in a range of sea environments, a major concern is the potential adverse effects on crew performance and capabilities caused by ship's motion. Seasickness is especially important on high-speed craft, as the combination of relatively small size, lightweight and high speed, results in higher vertical accelerations than on conventional ships. From an optimized manning point of view, one of the primary concerns when developing modern vessels is the degree to which debilitating motion sickness will be encountered by the crew. In addition to motion sickness, fatigue and drowsiness are frequent side effects of continuous ship motion. These effects can cause severe reductions in the human operator's vigilance and task performance, and it has long been recognized that various ship motions can compromise the ability of human operators to carry out both gross and fine motor activities that are essential for successful and efficient operations at sea. The impact on human cognitive ability and cognitive workload of sustained ship motion at both low and high ship speeds, as well as the angular placement of seated watchstations, are not fully understood. Therefore, it is important to examine whether standard-hull motion curves apply to the new hull forms, and if they do not then how will specific motion profiles associated with these new hull forms and sea environments degrade human performance. Once the motion-induced, performance degradation mechanisms are known, design solutions or guidelines that alleviate the negative effects on human performance caused by ship motion can be implemented. The Navy need is for design specifications and guidelines relating ship hull and on-board, sailor-operated equipment that will prevent these motion profiles that exceed human limits for acceptable individual and team performance. These specifications/guidelines must be based on empirical research using a ship motion simulator or actual ships. These specifications must be field tested at sea. The product of this research will be:

1. Specifications of six degree of freedom motions and accelerations that prevent the degradation of human performance and capability to the point of being unacceptable.

2. The design rules and/or tools to be implemented for other hull types/motion effects.
Expected product would be an expansion of existing motion effects data to include motions more relevant to innovative hull forms. However, this project may also yield new ways to measure and characterize motion effects on performance.

PHASE I: The government in collaboration with the awardee will define a set of ship motions and hull forms to evaluate. Demonstrate the feasibility of research approach; identify the research methodology that will be employed; identify applicable existing findings and identify gaps in the current state of knowledge. Identify cognitive tests to be conducted for the data generation. Proposed test lab setups will be described. Preliminary test cases meeting the requirements in the "Description" section will be generated. Any motion simulators or actual ships to be employed for this research will be identified. Any customized lab equipment required to complete this SBIR will be described. Describe how data will generate final ship design specifications or guidelines. Prepare Preliminary Phase III Transition Plan.

PHASE II: Develop the design specifications appropriate to the hull forms tested. Motion data from specified hull forms will be correlated to motion-related performance degradations. Produce motion specifications and guidance, which is human tolerance and performance based, and will provide for the optimum human performance for given motion profiles. Specifications will extend dimensions of the ISO 2631/3 Standard. Prepare the Final Phase III transition plan.

PHASE III: Work will begin in accordance with the Phase III transition plan to incorporate these ship motion specifications into Navy, Coast Guard, and commercial shipbuilding specifications and contracts. Commercialization opportunities, based on design/investigation rules, with regards to other hull forms and transportation systems will also be investigated.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The adverse impact of ship motion on human performance is a problem for a wide variety of commercial maritime enterprises wherein precise and sustained human performance is required to prevent hazards to personnel safety and health, and hazards to the environment. These include operation of drill ships and offshore platforms, operation of small boats and craft in conjunction with offshore activities, and operation of tugboats and barges in confined and crowded waterways. The long-haul trucking and cruise line industries are also potential beneficiaries of this research.

REFERENCES:

1. Benson AJ. "Motion sickness". In Dix, MR, Hood, JD (Eds), Vertigo, John Wiley & Sons, Ltd, Chichester, 1984.

2. Dobie TG, McBride D, Dobie T Jr., May JG. "The effects of age and sex on susceptibility to motion sickness". Aviation, Space, and Environmental Medicine. In press. 2000.

3. Griffin, MJ. "Handbook of Human Vibration", Academic Press, London, 1990.

4. International Standard ISO 2631/3, Evaluation of human exposure to whole-body vibration - Part 3: Evaluation of whole-body z-axis vertical vibration in the frequency range 0.1 to 0.63 Hz, 1985-05-01

5. Lawther A, Griffin MJ. "The motion of the ship at sea and the consequent motion sickness amongst passengers". Ergonomics. 1986; 29(4): 535-552.

6. McCauley ME, Royal JW, Wylie CD, O'Hanlon JF, Mackie RR. "Motion sickness incidence: exploratory studies of habituation, pitch and roll, and the refinement of a mathematical model", Technical Report 1733-2, Human Factors Research, Santa Barbara, CA, 1976.

7. O'Hanlon & McCauley. "Motion Sickness Incidence as a Function of Acceleration of Vertical Sinusoidal Motion", Aerospace Med. 45 (4): 366-369, 1974.

8. Reason JT, Brand JJ. Motion Sickness. Academic Press, New York, 1975.

9. Riccio GE, Stoffregen TA. "An ecological theory of motion sickness and postural instability". Ecological Psychology. 1991; 3(3): 195-240

KEYWORDS: Motion; motion sickness, human performance; vibration; environment

N03-060 TITLE: Methods & Metrics to Measure the Impact of Knowledge Superiority Technologies on the Warfighter

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: The objective of this SBIR topic is to provide a set of metrics that will be used to evaluate various technologies in terms of warfighter performance. This would take the form of mapping selected hardware and software technologies with respect to demonstrated improvements in warfighter situational awareness, task performance, timeliness and effectiveness of command decisions and impact on shipboard manning/manpower requirements. End products from this SBIR are expected to provide an objective basis for guiding technology investment/insertion decisions to support both near and longer-term ship acquisition programs.

DESCRIPTION: This research effort combines two Science and Technology R&D proposals that were identified in US-UK Technology for Optimizing Manning (TOM) workshops, namely the "Human Element of Knowledge Superiority" and "Situational Awareness Information Collection, Fusion, and Management". Although several organizations in the US and UK are studying issues associated with the attainment of knowledge superiority and enhanced situational awareness, most are focusing on hardware and software "solutions" to the problem. The principal issue addressed in this SBIR topic concerns the extent to which selected hardware and software technology items significantly improves warfighter situational awareness, task performance, the timeliness and effectiveness of command decisions, as well as their impact on shipboard manning/manpower requirements (e.g., decrease, no change, increase). The key is how to measure this effectiveness, and hence the requirement for metrics and methods of evaluating warfighter performance using various technologies. Today's traditional method is to wait until after design and attempt to derive these metrics for evaluation. Unfortunately, this is too late - the design is finished. Engineers early in the design of complex naval systems can use a standard or general set of human performance evaluation methods and metrics, tailored to technologies.

PHASE I: Demonstrate the feasibility of an approach to provide human performance assessment methods and metrics that will measure and validate the following hardware and software technologies in relation to improving warfighter situational awareness, task performance, timeliness and effectiveness of command decisions as well as impact(s) on shipboard manning/manpower requirements.

(a) Three-dimensional (3-D) visual displays

(b) Large screen (i.e., group) visual displays

(c) Fully or partially automated data fusion, integration and decision support systems (e.g., via intelligent software agents, assistants or avatars)

(d) Distributed collaboration tools (e.g., live video, text or audio chat, whiteboards, group document sharing and mark-up functions)

(e) Distance technologies (e.g., supporting operations, maintenance, medical, training, and logistics functions from remote/off-ship locations

(f) Advanced alerting and warning systems (e.g., visual, auditory, tactile)

(g) Advanced computer input/output devices (e.g., speech, gestural, eye or laser pointer controlled).

Baseline a selected set (to be chosen by government and contractor) of these methods/metrics for one or more specific technology areas.
Linkage between system functions and technology performance improvement must be shown. Architecture shall cover technology benefits and investment. Awardee will provide validation methods and data. Sufficient validation data must be provided to adequately validate architecture. Prepare Preliminary Phase III Transition Plan.

PHASE II: Design and build automated tool to implement the Phase I architecture. Validate methods and data of a selected subset (chosen in Phase I by government/contractor). Using these validated methods and data, validate the tool. A critical factor in effecting this mapping is to ensure that there is sufficient evidence in the literature to support a recommendation for transitioning the technology to Fleet operational use; specifically, in terms of the improvement(s) each technology item brings to the warfighter's situational awareness, task performance, timeliness and effectiveness of command decisions and impact on manning/manpower requirements. The awardees shall also construct and demonstrate a prototype computer-based tool to guide technology investment/insertion decisions made by program officers and systems engineers for near and longer-term ship acquisition programs. Prepare Final Phase III Transition Plan.

PHASE III: In accordance with the Phase III Transition Plan, apply taxonomy process and tool end-products developed and validated in Phase II to other operations/technology investment areas to identified government stakeholders, including the UK Applied Research Programme (ARP) and eight of the US Future Naval Capabilities (FNCs). Commercialization opportunities will be explored.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private-sector applications involving the use of Phase II architecture to investigate operations improvements for manufacturing and control systems. Areas where validated methods and metrics would serve as a useful decision-aiding tool, mapping operator roles and tasks to hardware/software capabilities, are air traffic control systems, harbor control and port entry systems, and offshore oil platforms/commercial maritime industries.

REFERENCES:

1. http://www.ehis.navy.mil/tp/humanscience/masakowski/dera/intro.htm provides an overview to and presentations made at the US-UK Technology for Optimized Manning workshops, and a database of tools for each technology.

2. www.manningaffordability.com contains a wide variety of items and documents pertinent to this SBIR.

3. The following documents may provide useful information and guidance for the construction of the Phase I multidimensional matrix/taxonomy:

a. Fleishman, E.A., and Quaintance, M.K. (1984). Taxonomies of human performance: The description of human tasks. Orlando, FL: Academic Press

b. Mallamad, S.M., Levine, J.M. and Fleishman, E.A. (1980). Identifying ability requirements by decision flow diagrams. Human Factors, 22(1), 57-68.

c. Seven, S., Akman, A., Muckler, F.A., Knapp, B.G., and Burnstein, D. (1990). Development and application of military intelligence (MI) Job Comparison and Analysis Tool (JCAT). Fort Huachuca, AZ: U.S. Army Research Institute, ARI Field Unit.

KEYWORDS: Knowledge Superiority; Situation Awareness; Data Collection; Information Collection; Human Systems Integration; manning and manpower requirements

N03-061 TITLE: Simulation of Low Frequency (< 2 GHz) EMI and Coupling in Shipboard Environments

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: Topic N01-184 requested development of a means of modeling inter-element interactions in a large, finite phased array aperture to predict properties of a single array, as well as inter-aperture coupling in free space. In this effort the objective is to develop a physics-based computer simulation program that facilitates the efficient design of multiple low frequency VHF to L-band (30 MHz-2 GHz) RF apertures operating in modern shipboard environments. At low frequencies the physical model requires a lower degree of structural detail than models covering high frequency. In addition, particularly in the VHF, where antenna spacings may be on the order of 1l and an entire hull may be on the order of 10l, modeling approaches based on a method of moments or FDTD technique may be suitable. Solutions are further complicated by non-PEC surfaces including dielectric and composite materials. The software should be able to accurately predict the scattering and EMI coupling characteristics these apertures. The simulations should be capable of analyzing both closely spaced and widely separated apertures, and include coupling through typical shipboard structures, including mast and FSS structures. The apertures may consist of any of a number of antenna types including: reflectors, rotating arrays, dipoles, or antenna arrays.

DESCRIPTION: The scope of this effort can be broken down into several steps. Modeling of direct and indirect coupling could, for example, be sub-divided into Complex Environment Scattering and Aperture-Aperture Coupling. Boundary conditions for these tasks will include PEC, Absorber, Composite, FSS, and combinations of materials. The work is in support of topside design for future surface combatants.

The performance of an aperture operating in a topside environment may significantly differ from the predictions of isolated aperture simulations. Therefore, a Complex Environmental Scattering capability to allow characterization of the performance (including multi-path effects) of an aperture operating in a topside environment is necessary. The enhanced code will calculate the complete near field RF power radiated in the topside environment. This information is necessary in order to accurately simulate the aperture performance with realistic topside structures.

In addition, because there is likely to be direct coupling between apertures, the software is required to model the effects of energy coupling between topside apertures. The intervening medium between the apertures may be a perfect conductor, a composite material, absorber, and/or FSS radome. These coupling effects are of critical importance to the design engineers and will determine the proper placement of adjacent systems.

PHASE I: Develop accurate numerical technique for analyzing direct and indirect coupling characteristics of apertures in the VHF to L-Band regime, for the PEC boundary condition. No specific physical model is specified for this effort. The developer is encouraged to validate the resulting technique against data in the literature. In addition, both numerical and measured data for smaller, finite arrays are available from SPAWAR Systems Center San Diego. Demonstrate how these results can be extended to other boundary conditions.

PHASE II: Develop software module based on the technique developed in Phase I, complete with graphical user interface, to handle both direct and indirect coupling of apertures with a complex inter-aperture medium, as noted above. These apertures may or may not be closely spaced. Provide a complete solution from near field through intermediate and far field. Validate the results for pattern modification and coupling effects by comparing with measured data either published in the literature, or provided by the Navy through SPAWAR Systems Center or other Navy laboratories.

PHASE III: This modeling and simulation (M&S) tool technology will be used by the Navy and contractors to design and evaluate electronic systems for the DD(X). This technology is critical to designing and evaluating the effectiveness of the integrated topside design. It is expected that the user base of this technology will continue to grow with the increased us of integrated complex electronic systems in DoD applications. With the rapid expansion of the Information Technology sector, increased requirement for a M&S tool that accurately predicts antenna performance is essential.

COMMERCIAL POTENTIAL: The commercial world will benefit directly from this software module in solving EMI/Coupling problems, e.g., companies in the communication business.

REFERENCES:

1. K. Umashankar and A. Taflove, Computational Electromagnetics, Artech House, Boston. 1993.

2. A. Taflove and S. Hagness, Computational Electrodynamics: the finite-difference time-domain method, 2nd edition, Artech House, Boston. 2000.

3. M. Salazar-palma, T. Sarkar, L-E. Garcia-Castillo, T. Roy, A. Djordjevic, Iterative and Self-Adaptive Finite-Elements in Electromagnetic Modeling, Artech House, Boston. 1998.

KEYWORDS: scattering; EMI coupling; direct coupling, indirect coupling

N03-062 TITLE: <u>High Frequency (> 2 GHz) Inter-Aperture Direct Coupling and Radiation</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: Develop physics-based computer simulation program that models direct coupling and radiation characteristics of multiple high frequency S-band and higher (>2 GHz) RF apertures operating in modern shipboard environments.

DESCRIPTION: Due to differences in the physical phenomena associated with high and low frequencies, and therefore the differences in physical models appropriate for high and low frequencies as noted below, a similar program topic has been proposed to cover coupling between apertures at lower (< 2 GHz) frequencies. At high frequencies the physical model requires a greater degree of structural detail than models covering low frequency. At higher frequencies the inter-aperture separations are typically greater than 10l and ships structures can exceed 103l in dimension, suggesting asymptotic approaches. Solutions are complicated by non-PEC surfaces including dielectric and composite materials. The simulations should be concerned with intra-platform aperture coupling, including both the case where the apertures are closely spaced, such as for apertures co-located on the same mast, and the case where the apertures are widely separated, such as at opposite ends of the platform. The simulations should also include aperture coupling through shipboard structures, including masts and Radome (FSS) structures. The apertures may consist of planar phased arrays, or any of a number of legacy antennas, e.g. a parabolic reflector.

Modeling of topside apertures will principally be concerned with Aperture-Aperture Coupling and Aperture Performance in a Complex Environment. The inter-aperture medium will provide boundary conditions for the coupling problem that will include PEC, Absorber, Composite, FSS, as well as a potentially complex combination of materials, such as for a radome and supporting structure. These coupling effects are of critical importance to the design engineers and will determine the proper placement of adjacent systems. The software must also determine modified radiation characteristics for apertures operating in complex environments. Additionally, RF power levels in the vicinity of the ship are important for RADHAZ analysis. This work is in support of topside design for future surface combatants.

PHASE I: Develop accurate numerical technique for analyzing direct inter-aperture coupling and radiation characteristics for apertures operating in the S-Band and greater regime, for the PEC boundary condition. Validate the techniques using canonical problems and by comparing the results in the limits where alternate EM modeling tools (including, but not limited to, CARLOS 3D) are currently available. Demonstrate how these results can be extended to other boundary conditions.

PHASE II: Develop software module based on the technique developed in Phase I, complete with graphical user interface, to handle direct coupling of apertures with a complex inter-aperture medium, as noted above. These apertures may or may not be closely spaced. Provide a complete solution from near field through intermediate and far field. Validate the results for pattern modification and coupling effects by comparing with measured data provided by the Navy through SPAWAR Systems Center or other Navy Laboratories.

PHASE III: This modeling and simulation (M&S) tool technology will be used by the Navy and contractors to design and evaluate electronic systems for the DD(X). This technology is critical to designing and evaluating the effectiveness of the integrated topside design. It is expected that the user base of this technology will continue to grow with the increased us of integrated complex electronic systems in DoD applications. With the rapid expansion of the Information Technology sector, increased requirement for a M&S tool that accurately predicts antenna performance is essential.

COMMERCIAL POTENTIAL: The commercial world will benefit directly from this software module in solving EMI/Coupling problems, e.g., companies in the communication business.

REFERENCES:

1. K. Umashankar and A. Taflove, Computational Electromagnetics, Artech House, Boston. 1993.

2. A. Taflove and S. Hagness, Computational Electrodynamics: the finite-difference time-domain method, 2nd edition, Artech House, Boston. 2000.

3. M. Salazar-palma, T. Sarkar, L-E. Garcia-Castillo, T. Roy, A. Djordjevic, Iterative and Self-Adaptive Finite-Elements in Electromagnetic Modeling, Artech House, Boston. 1998.

KEYWORDS: scattering; EMI coupling; direct coupling, indirect coupling

N03-063 TITLE: Affordable, Flexible, Network Capable Application Processor for Data Acquisition and Processing

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 - DD(X)

OBJECTIVE: Develop an affordable, flexible, networked data acquisition and processing system capable of acquiring data from numerous sensors and processing and transmitting that data via a wireless and wired network. The system will be programmable, make maximum use of open standards and open systems architectures and will be compact and ruggedized for the shipboard environment.

DESCRIPTION: To successfully achieve reductions in workload/manning and Total Ownership Cost (TOC) of Naval vessels requires innovative approaches to handling tasks traditionally done by personnel. Manual collection of equipment data needs to be reduced or eliminated and condition-based maintenance based on advanced diagnostics and prognostic algorithms must be widely adopted. The Navy concept is for highly sensorized, automated ships with many thousands of sensors installed on hundreds of ship systems. To achieve this vision a mechanism must be developed to affordably collect and process this potentially huge volume of data.

Combining the capabilities of wireless networks, wireless sensors and standardized sensor interfaces can enable cost-effective, extensive, condition-based monitoring of shipboard equipment and other analyses based on equipment information. A Network Capable Application Processor (NCAP) is needed that has the capability to communicate via a wireless and wired LAN and that can receive, and process as necessary, input from a large number of wired and wireless sensors. The device should be capable of communicating with IEEE 802.11b wireless LANs initially but should be easily upgradeable to other wireless network protocols. The device should be able to handle at least 100 wired, legacy sensors as well as larger numbers of advanced sensors and wireless sensors. The NCAP should be easily configurable and compatible with open systems architecture standards such as IEEE 1451, however, for legacy sensors the NCAP should also have the capability to interface to sensors not compliant with IEEE 1451. The open systems approach taken should consider standards being developed such as IEEE 1451.3 and 1451.4 and potential standards such as 1451.5.

To provide flexibility, capability and manage network bandwidth the NCAP should be programmable and capable of data analyses and data fusion to reduce the amount of data that must be transmitted over the network. The device should provide flexibility and customizability in the type of output it can produce but should be capable of producing output in relevant standard formats for the types of data or information being transmitted.

Since a significant number of these devices would be needed on a highly sensorized ship, the device/system must be small enough to accommodate installation of all needed devices to monitor potentially thousands of signals in the limited space available on Naval vessels or other military or commercial applications with limited space. The system must be ruggedized for use in a shipboard environment. System design should consider military requirements for shock (MIL-STD-901D), vibration (MIL-STD-161), humidity (MIL-STD-810), EMI (MIL_STD-461E) and other environmental concerns. Since a large number of these systems may potentially be needed the system must be affordable in initial cost and over its life cycle.

PHASE I: Create a development plan for an NCAP with LAN and WLAN interfaces capable of handling inputs from at least 100 wired sensors via 1451 interface, legacy interfaces or wireless interfaces. Define potential to increase exploitation of current and future commercial and military systems, use of open interfaces, and develop a design concept. Provide report that details the concept, suggested metrics and estimated life-cycle costs.

PHASE II: Complete system design of concept developed in phase I, build prototypes and test system, in a laboratory or shipboard, for applicability for use in a shipboard environment. The contractor shall work with the government sponsor to test the proposed device/system for applicability to the proposed DD(X) family of ships and existing fleet vessels. This may require working with the commercial DD(X) design team.

Document approach, full-scale system ship impacts (size, weight, acquisition and lifecycle costs, projected workload impacts, etc.) and projected capabilities and components. Demonstrate capabilities, security impacts, and electromagnetic and other interferences/compatibility under multiple operational condition scenarios.

PHASE III: Develop transition plans and demonstrate the commercial and shipboard use of system. Develop commercial product and perform full-scale shipboard demonstrations. Perform all relevant testing of device for conformance to relevant military specifications. Develop marketing plan for wide-scale Navy implementation and commercial marketing plan.

COMMERCIAL POTENTIAL: Wireless technology represents one of the fastest growing sectors of the IT market. Wireless LANs are in use in a number of commercial applications including industrial plants, office buildings, universities, etc. Condition-based maintenance and equipment monitoring can enable significant cost savings if economy of scale can be achieved. A system capable of collecting equipment information from a large number of sources and transmitting that data without requiring installation of extensive network wiring will facilitate wider implementation of such cost saving methodologies.

REFERENCES:

1. IEEE Standard for a Smart Transducer Interface for Sensors and Actuators - Network Capable Application Processor Information Model, IEEE 2000;Softcover;2000;ISBN 0-7381-1767-6; Product No.: SH94767-TBR; IEEE Standard No.: 1451.1-1999

2. Standard for a Smart Transducer Interface for Sensors and Actuators - Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats, IEEE 1997; Softcover;1997;ISBN 1-5593-7963-4; Product No.: SH94566-TBR; IEEE Standard No.: 1451.2-1997

3. ISNS PPL/QPL Test Report: Wireless Local Area Network (WLAN), August 31 2000, SPAWAR, Rev 2.1, Integration Test Facility, SSC SD. (Report available in Adobe Acrobat format from topic writer)

4. http://grouper.ieee.org/groups/802/11/

5. ANSI/IEEE Standard 802.11, 1999 Edition

6. IEEE Std 802.11b-1999

7. IEEE Std 802.15.1-2002

8. Draft DoD Wireless Policy (DoD 88XX.aa, Version 4.2b, April 01, 2002)

KEYWORDS: Sensor, STIM, NCAP, Wireless, RF, Local Area Network, LAN, WLAN, IEEE 1451

N03-064 TITLE: Kinetic Energy Penetrator Payload for EX 172 Cargo Round

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMS 529: Gun Weapon Systems Technology PGM, Naval Surface Fire Support

OBJECTIVE: Provide a non-explosive lethal mechanism for projectiles such as Cargo Round to leverage the kinetic energy imparted to the projectile by the gun. It is intended that this approach will reduce warhead costs, eliminate the explosive hazard of submunitions during shipboard storage, and eliminate the hazard of unexploded submunitions remaining on the battlefield during post-battle operations. The most significant problem that needs to be solved in this topic is to dispense the kinetic penetrators uniformly within the lethal area at supersonic speeds.

DESCRIPTION: Lethality models have predicted that a payload of kinetic energy penetrators has greater lethality than a comparable payload of submunitions, when delivered by a projectile with sufficient velocity. The EX 172 Cargo Round projectile, when fired from the upgraded 5"/62 Mk 45 Mod 4 gun, has adequate velocity for a penetrator payload to be effective. Additionally, the penetrators must be deployed in a way that will disperse penetrators uniformly over a large footprint. The penetrators cannot be dispersed too early, or their aerodynamic drag will slow them below lethal velocity. Similarly, sloppy dispersal that causes tumbling will negate their effectiveness.

This topic seeks the design of an optimum kinetic payload for a gun launched projectile that will fit in a cavity 13.8 inches in length and 3.68 inches in diameter. The warhead design consists of properly packaging a large number of penetrators, their deployment mechanism, along with development of a suitable penetrator shape that can be manufactured cost effectively. The contractor has the latitude to develop a packaging approach and release mechanism to make the payload safe to produce, store, and launch, economical to procure, and lethal to use against a target as well as select materials and establish penetrator size. The performance of this warhead is being optimized against an asymmetrical ship defense target. If successful, down the road, this ability to uniformly dispense kinetic energy against targets will be applied to Naval Surface Fire Support area targets, such as personnel (infantry, weapon crews, and vehicle drivers for example), vehicles (trucks and light armored vehicles), and unarmored equipment (missile launchers, radars, fuel and weapons dumps). Of these, infantry personnel and trucks make up the majority of targets. It is desired that the payload provide the maximum safety in manufacturing, shipping, and storage, consistent with its mission lethality. It is desired that it qualify as a Division 1.3 (Class B) explosive, and preferable Division 1.4 (Class C). Expended or dud rounds should not present a hazard on the battlefield. The payload must survive gun launch acceleration, including balloting loads and rebound at muzzle exit. It must be initiated by the fuze action of the Cargo Round's Multi Functional Fuze.

PHASE I: Develop the feasibility of the proposed approach to produce a uniform dispense pattern of lethal effects against personnel operating from high speed boats. Assess its lethality against troops and trucks using Joint Munitions Effectiveness Manual methods.

PHASE II: Fabricate a prototype of the payload and demonstrate its operation.

PHASE III: The payload will be integrated into the EX 172 Cargo Round. The Phase III effort will include weaponization, assessment of conformance to Insensitive Munitions requirements, and lethality testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The topic authors believe that the primary technology innovation in this topic will be the development of a rapid deployment mechanism that minimizes the amount of energetic material and does not present an explosive hazard is needed in commercial safety systems, for example, next generation air bag deployment mechanisms for automobiles. Another application for this rapid deployment/ejection mechanism might be in manufacturing processes involving injection molding or explosive forming.

REFERENCES:

1. Drawing # 7343710 Projectile Body, 5 Inch/54 Caliber Cargo

2. Drawing #7343709 Plug, Base

KEYWORDS: flechette, packaging, release mechanism, penetrator, Beehive Round, kinetic energy, lethality, uniform pattern, supersonic dispense

N03-065 TITLE: Gradiated Gun Barrel Fabrication Process

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 529: Gun Weapon Systems Technology Pgm. Naval Surface Fire Support

OBJECTIVE: Develop and demonstrate a process for fabricating a gun barrel or liner component in which the material provides a nearly linear gradient in material and density from a fully ceramic interior to a fully metallic exterior.

DESCRIPTION: In the past, guns such as the Mk 45 Mod 2, which fired conventional ammunition with NACO propelling charges sustained a barrel life of 8000 rounds. These barrels were replaced because the material was reaching its fatigue limit. Current Guns, such as the Mk 45 Mod 4, use munitions such as the ERGM round and the EX99 propulsion charge. With this combination the barrel life is expected to be only 1500 rounds because of erosion that takes place within the barrel. To support future guns, firing high temperature propellants, with large charges, at high rates of fire (a sustained rate of 12 rounds/minute for 750 rounds fired), we require advanced materials. These materials must have strengths comparable to current gun barrel steels, must be erosion resistant when subjected to high flame temperature propellants (EX99, JA2, etc.), must be resistant to chemicals and mechanical wear, and must be capable of withstanding mechanical and thermal cycling loads. More specifically, approaches that use materials with low thermal conductivity at the gun bore surface will reduce the heat absorbed into the barrel. By reducing the temperature reached by barrel layers further out from the bore, there is less need for large quantities of materials that can operate at high temperature ranges. It is also desirable that the outer material be highly heat conductive so that the heat that is absorbed into the barrel at the bore surface will be rapidly conducted into the outer regions, thus lowering the average bore temperature.

Previous attempt to provide ceramic linings or coatings to metallic gun barrels suffered from poor strength at the ceramic-metal interface, particularly during temperature and mechanical cycling. For this reason, this topic seeks a process to fabricate a material that would gradually change from pure ceramic at the bore, through a mixed ceramic-metal matrix, to a pure metal composition, ensuring a strong bond between the ceramic and metal and spreading out the thermal and mechanical stresses through the gradient area. The metal outer layer would then interface with conventional metal barrel material or a composite structure.

Note that this topic is not for a "functionally graded material," which layers different materials within a composite structure. It seeks a single liner material with a smooth gradient from one composition to another.

PHASE I: Prove feasibility by developing a process for producing a ceramic-metal gradient material that would be suitable for objects the size of a 5-inch, 155 mm, or 8-inch barrel liner. Demonstrate the process at bench scale and conduct an initial characterization of the material.

PHASE II: Demonstrate scale-up of the process to pilot scale. Fabricate and test fire a short barrel section.

PHASE III: Contractor shall work with the Navy to incorporate this process into an advanced gun barrel, which will be produced as a follow on to the 155 mm fire support gun now in development.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This gradient material would be an improvement on current ceramic coatings used in large diesel engines, offering greater insulation, higher-temperature operation, and longer life span. It could also be used on brake rotors, flywheel and pressure plate surfaces in clutch mechanisms, stoves and boilers, or any surface that is prone to thermal or mechanical wear and erosion.

REFERENCES: Since a material of this type has never before been developed for use in gun barrels, there are no background documents or standard testing procedures that can be provided.

KEYWORDS: ceramic, gradient, metal matrix, gun; erosion, insulation

N03-066 TITLE: Hot Gun Barrel Detector for Navy Guns

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMS 529: Gun Weapon Systems Technology program, Naval Surface Fire Support

OBJECTIVE: Develop a novel approach in the design of a reliable gun hardened temperature-sensing device that could provide real time measurements at the bore surface approximately 40 inches from the breech end of the gun barrel and relay that information to the gun control panel located within the gun mount.

DESCRIPTION: This task is intended to develop a primary method of determining the temperatures in the 5-inch/62-caliber (5"/62) EX 36 MOD 0 gun barrel when in service on a ship equipped with the MK 45 gun mounts. Knowing this information is critical in the event of an inadvertent misfire (propelling charge does not ignite). The gun crew must know how hot the bore surface is, in order to decide if they have time to safely open the breech, remove the ammunition from a hot gun barrel, replace the propelling charge, and fire the projectile before enough heat has transferred from the hot barrel possibly initiating a cook off of the projectile or propelling charge. Temperatures can reach as high as 800 degrees F. Currently the crew has to rely on a simplistic hot-gun predictor (chart) originally developed for use with the 5"/54 MK 45 MOD 2 gun. It has been recently determined, based on results from gun firing tests and thermal modeling, that this hot gun predictor might be either excessively conservative or very non-conservative depending on the circumstances prior to a misfire incident when advanced projectiles and higher energy propelling charges currently under development are used.

The intent of this task is to develop a novel temperature sensing device that could be either mounted in the gun barrel near (but not on) the bore surface or a device that can be pointed at the location of interest within the gun barrel just prior to loading the ammunition and closing the breech (for instance, an infrared detector mounted on the gun mount, aft of the breech). For the embedded case, the diameter of the hole drilled from the outside of the barrel must be less than ½ inch (¼ inch desired) and approximately ¼ to ½ inches from the bore surface. The exterior mounted sensor approach would have to consider the presence of smoke and debris obscuration in the barrel when the breech is opened. Other highly desired attributes requiring novel technology to be developed include the ability to consistently withstand a high-G gun recoil environment, wirelessly transmit data to the gun control panel, and provide redundancy and/or self calibration.

PHASE I: Develop and determine the feasibility of the proposed approach for sensing the in-bore temperature of a Navy gun barrel.

PHASE II: Develop and demonstrate prototype sensors for sub-scale testing. Provide Navy with a sensor to be mounted in their test gun for full scale testing.

PHASE III: It will be demonstrated that the sensor system will survive in extended gun firings and accurately measure barrel temperatures. Contractor will work with the Navy to integrate the sensor with the gun control system. It is intended that the technology will be transitioned into the Navy's new 5"/62 MK 45 MOD 4 gun mount.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be applied in any situation involving high temperature monitoring in extreme, hard to get to, high shock environments, and machinery components rotate or oscillate. Examples are: industrial processes such as steel forgings, power generation plants; destructive testing of building and aircraft structures in flame environments; steel production and other metallurgical environments; and fire-fighting training devices. The topic authors view this as an opportunity to "spin on" commercial technology to the military market, as the environment in the gun mount is not as severe as that at a steel forge. Research and development would, for example, focus on reducing the size and cost of a steel forge non-contact temperature sensor to fit inside the gun mount.

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KEYWORDS: temperature; sensor; gun; monitor; hot; barrel; cook off

N03-067 TITLE: Pre-fragmented Warhead Plate for EX 171 ERGM

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMS 529: Gun Weapon Systems Technology program, Naval Surface Fire Support

OBJECTIVE: Develop a pre-fragmented plate for use in a unitary warhead for the EX 171 Extended Range Guided Munition. This plate must be strong, to survive the forces of gun launch, and yet be weak, to break into fragments without wasting energy from the warhead explosive

DESCRIPTION: Current gun projectile bodies are inefficient as warheads because their strength causes them to break into a small number of large, irregular fragments. Greater lethality is possible if the fragments are smaller and more uniform. Missile warhead use pre-fragmented or pre-scored metal for their warheads, but in gun projectiles, these flaws weaken the metal too much for it to survive the shock of gun launch. If the metal is thickened or supported by another structure, much of the explosive energy is lost to breaking apart the strong structure. These constraints are particularly limiting in the geometry desired for the EX-171 ERGM unitary warhead. Because of a requirement to attack dug-in troops and equipment, the ERGM warhead favors a top-attack, forward firing design. This geometry places the fragmenting plate in a shell-buckling or plate-buckling mode.

Under gun launch loads, the plate must withstand both set-back forces (where its domed shape is an advantage) and set-forward loads when the projectile leaves the muzzle (placing a domed structure into tension).

This topic seeks the design of pre-fragmented or fragmenting plate for a five-inch diameter, forward-firing warhead. This plate will, by using the contractor's innovative technology, provide sufficient strength to survive gun launch and also efficiently fragment into numerous uniform fragments. The most effective plate would be made of a dense metal like tungsten or tantalum, but the contractor will have flexibility to choose the material, balancing the issues of strength, density, and fabrication costs. System objectives are to maximize the number and velocity (at target impact) of lethal-sized fragments; this objective strongly favors dense metals over steel. System cost goal is $500 to $1000 for the plate in production, including any supporting structure (if the contractor pursues a composite design). The warhead is intended for use against Naval Surface Fire Support area targets, such as personnel (infantry, weapon crews, and vehicle drivers for example), vehicles (trucks and light armored vehicles), and unarmored equipment (missile launchers, radars, fuel and weapons dumps). Of these, infantry personnel and trucks make up the majority of targets. The warhead will also be used against asymmetrical ship defense targets, such as fast boats.

PHASE I: Demonstrate the feasibility of the proposed pre-fragmented warhead plate and develop an approach to manufacturing it at low cost. Demonstrate by analysis its survival of gun launch loads. Conduct any bench-scale tests needed to validate design assumptions. Predict its fragmentation performance and its lethality against troops and trucks using Joint Munitions Effectiveness Manual methods.

PHASE II: Fabricate a prototype of the plate. Validate the design predictions by demonstrating its survival of gun-launch loads and its fragmentation under explosive loading. The explosive loading demonstration can be conducted at subscale.

PHASE III: The plate will be integrated into a warhead for the EX-171 ERGM. The Phase III effort will include weaponization, assessment of conformance to Insensitive Munitions requirements, and arena and lethality testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial applications for this topic are including energy absorbing and crash-proof structures, like automobile crumple zones and highway crash barriers, that must provide strength but fail controllably and predictably. Additional commercial applications are a available for three possible technical approaches: 1) precision manufacturing methods, where the strength of the material is controlled within tight upper and lower bounds, 2) designs that exploit materials with strain-rate dependent strength, and 3) designs that combine crack-initiation-prone materials with crack-arresting bands. For example, precision manufacturing would have applicability to ductwork and fire dampers (a duct must be fastened securely to the damper, to withstand ordinary loads and seismic loads, but must break loose if a duct section collapses, so as not to compromise the smoke boundary.). In contrast the crack-arresting approach is broadly applicable to any structure that allows crack propagation within defined limits, such as panels or tank walls,

REFERENCES: EX-171 Prime Item Development Specification

KEYWORDS: fragment, pre-scored, strain rate, crack-arresting band, lethality, tungsten, tantalum

N03-068 TITLE: Term Geo-Political Context Decision Support Tool

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM:

OBJECTIVE: To produce a standard methodology and decision support tool
to support long term context development for force design and force planning efforts.

DESCRIPTION: Long term strategic planning for naval forces demands an evolving geo-political context that produces fiscally and culturally constrained alternative futures. This tool will assist force architecture analysis to be undertaken with consistent and validated predictions of future world geo-political states. The delivered product will be an automated tool that will permit rapid extraction from relevant external databases of economic assessments and prediction of various geo-political sates that may result. The results will form the basis for making future force architecture alternative design decisions.

PHASE I: Formalization, extension and validation of the methodology and design of the decision support tool that accesses external standard databases.

a. Geo-economic performance estimates. A spreadsheet method for projecting US and regional geo-economic performance was developed in 1990 with a 50-year projection. This phase will validate this model by comparing the 1990 projections of input data to actual performance from 1990-2001 and by comparing the output data to the actual global economic performance from 1990 to 2001. The model will be refined as necessary and extended to a more information-oriented economy.

b. Standardization of Geo-Political modeling for the Period 2000-2005. A methodology exists for characterizing state behavior in multiple possible geopolitical contexts. Test this scheme over the period 1980 to 2002 for robustness with particular emphasis on the historical transition from the Cold War to Post Cold War era. Extend the scheme to non-state entities.

c. A methodology exists for projecting intelligence futures using theoretical clever opponent techniques. Examine how well this scheme predicted the second and third world force development trend from 1990 to 2001 and extend the approach to non-state entities and to regional rivals.

PHASE II: Develop an automated decision support tool with automated extraction from relevant external databases.

PHASE III: Prepare a user-friendly package to support future force architecture analyses.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This tool, with appropriate parameter modifications, could be applied to any future world prediction needs.

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KEYWORDS: Economics, politics, force architecture, analysis, strategic planning.

N03-069 TITLE: Optimal Manning Analysis Tool for Grouped Forces

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMS 377: LPD 17 AMPHIBIOUS ASSAULT SHIP

OBJECTIVE: To design and develop an Optimal Manning Analysis Tool that will examine Navy grouped forces as a single integrated entity supporting interoperable and distributed warfighting capabilities in Network Centric Warfare (NCW).

DESCRIPTION: This research and development effort shall focus on developing a grouped force crew requirement trade study tool to answer "what if" questions to support grouped force-level trade studies for the Navy. Examples of grouped forces include Amphibious Ready Groups (ARG) and Carrier Battle Groups (CVBG). This generic tool will enable analysts and ship designers to understand grouped force mission, task and capability requirements and to predict their impacts on grouped force ship crew, Navy staff and Navy detachment manpower requirements and associated Total Ownership Costs (TOC). This tool will assist grouped forces to meet various combat and non-combat missions in regional conflicts and in amphibious and joint warfare around the globe.

This tool should adopt a systems engineering approach and use existing computer technologies to build a software tool to capture, manipulate, and analyze workload and crew data for ARGS from LHDs, LPDs, LSDs, Navy staffs and detachments; and for CVBGs from CV/CVNs, CGs, DDGs, DDs, FFGs, Navy staffs and detachments. The delivered product shall consolidate the ship, staff and detachment missions, capabilities, functions and tasks in an architecture for integrated Required Operational Capability/ Projected Operational Environment (ROC/POE) statements. This consolidation is a transformation from a platform-centric perspective to a grouped force-centric perspective, thus building a foundation for an eventual force-level integration. The delivered product shall include algorithms to optimize the crew requirements while reducing the Total Ownership Cost (TOC).

PHASE I: Research user requirements and prepare a system design for a Grouped Force Optimal Manning Analysis Tool. This tool shall be able to consolidate different existing workload databases and enable analysts to enter parameters of different operational scenarios to initiate a computerized process for crew requirement analysis. In addition, the system design shall include generating multiple performance assessments and cost reports for various mission profiles.

PHASE II: Develop, integrate and test the grouped force Optimal Manning Analysis Tool. Applications include mission, capability and task analyses; crew requirements; cost variance studies; and group performance assessment for both combat and non-combat environments involving complex network-centric warfare scenarios. Demonstrate the tool's ability to answer "what if" questions to support grouped force trade-off studies. Prototype demonstration will be required near the end of Phase II.

PHASE III: Prepare a user-friendly package to support grouped force-level trade study of workload analysis and cost effectiveness in a Network Centric Warfare environment. Provide a roadmap to expand Phase II products into a force-level tool.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This tool, with appropriate parameter modifications, could be applied to work environments for organizational re-engineering based on network centric operational concepts involving complex human machine interfaces, team interaction, and virtual office implementation and modeling.

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KEYWORDS: Cost, crew, workload, NCW, optimal manning, manpower, prediction, reduction, ARG, CVBG, integrated warfare, network-centric warfare, mission, capability, task, ROC/POE, and combat

N03-070 TITLE: Beam Control (BC) for Ship Self-Defense

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Design, develop, and demonstrate beam control subsystem that can be packaged for Naval platform applications.

DESCRIPTION: The goal of this topic is to design, develop and demonstrate an agile, compact laser beam director system capable of handling a 100 K W of laser power, for ship board application.

BACKGROUND: There have been several generations of beam control system developments. These include the developments in 70's and 80's and the recent ones such as Tactical High Energy Laser (THEL) beam control and Air Borne Laser (ABL) beam director which is currently under construction. The beam control systems, were developed to demonstrate the beam control fusibilities, concepts but never engineered for tactical environment such as for shipboard application in maritime environment. Every advanced weapon system is a product of the component and technology investments of the past. The current THEL beam control system is possible only because of the major beam control technology programs executed in the 1970's and 80's. They succeeded in demonstrating new subsystem developments conducted in the 1980's that led to the ability to conduct major HEL weapon demonstrations this decade.

It is the purpose of this effort to design and develop a compact maintenance free environmentally compatible beam control subsystem. Beam control is by far the largest and most complicated of the components of an HEL weapon system. It encompasses everything between the laser device itself and the target, assuming that one can divide these three essential features of a weapon. Some recent concepts have considered revolutionary ideas for performing beam control in a way that includes the laser device itself, and occasionally the target as well. We will specify the general characteristics of the laser device and the target parameters.

Of course, one could continue to study the conventional (or "evolutionary") beam control concepts, including some components and processes that occur even before the HEL beam itself is created. For example, Acquisition, Tracking, and Pointing (ATP) is a critically important component of beam control that sets the conditions for where the HEL beam goes once it is generated. This function requires advanced sensors that perform at high frame rates with low noise in several wavebands. The sensors report to control algorithms that perform the acquisition and tracking function, using high bandwidth Fast Steering Mirrors (FSM) and other optical components. ATP can also require precise gyros, Inertial Reference Units (IRU) to provide a stable reference for the HEL Line Of Sight (LOS). Controlling the devastating effects of the HEL beam using the ATP suite sometimes is referred to as Fire Control (FC), so that we can discuss Beam Control/Fire Control (BC/FC) or ATP/FC functions.

Generally, once the target is being precisely tracked, the HEL beam must be sensed and corrected in a local loop, using Deformable Mirrors (DM), Fast Steering Mirrors (FSM), or other components. If the PM aperture is shared with the ATP suite, then novel components such as Aperture Sharing Elements (ASE) must also be present.

HEL weapons system for shipboard operates in the maritime atmosphere. A critical component of beam control is the propagation of the HEL beam from the exit aperture of the weapon system to the target through this atmosphere. Deleterious effects such as turbulence, scattering, and thermal blooming can degrade the HEL to the point of uselessness if not treated properly. So understanding of the effects of these atmospheric propagation disturbances and ameliorating those effects are also part of the beam control design function.

Therefore, the traditional beam control function comprises an ATP suite, a "Local Loop (LL)" correction system for the HEL device, a "Target Loop (TL)" correction system for the portion of the HEL beam path between the ASE and the target, and the (usually atmospheric) propagation to the target.

The technologies involved in the beam control system development include vital components (Relay Mirrors, sensors, FSM, DM, IRU, ASE, windows, illuminators, coatings, etc), control algorithms (acquisition, tracking, wave-front control, aim-point selection / maintenance, atmospheric compensation, etc.), diagnostics (sensors, optics, calibration techniques), integration, and testing (simulation, laboratory, atmospheric characterization, field tests).

Although beam control technology in general has been judged to be mature enough to produce major HEL system development programs, there remain many beam control technology issues to contend with in these systems. Examples exist for all systems, including components such as HEL windows, illuminator lasers, low noise sensors, and aperture sharing elements.

The way we chose to evaluate beam control technology was in terms of the ability to deliver a particular fluence to the target. HEL weapons work by thermally degrading particular parts of a target, so the fluence that must be accumulated at the target is a critical parameter that drives the beam control system performance.

Kilowatt class laser systems have been demonstrated by a number of groups, but corresponding tactical beam control systems have been lacking. The DoD High energy Laser Master Plan (HELRP) recommends that the DoD stimulate the High-Energy Laser supplier base with a few focused investments. Specifically, under beam control area, the top three priority investments are (1) Development of optical beam control techniques for:

PHASE I: Investigate enabling component and beam control technologies that are capable of enabling specific beam control requirements listed above. Demonstrate component design feasibility via modeling and simple sub-scale experiments.

PHASE II: Utilize the findings established in Phase I to design, development a functional beam control subsystem satisfying the above requirements. Conduct Beam control demonstration. Conduct integration requirements study to develop specifics of a shipboard integration requirements.

PHASE III: Implement the integration requirements enabling the demonstration of the beam control system of phase II on a Navy provided platform.

PHASE III DUAL USE APPLICATIONS: Many applications in materials processing require the use of high power laser beams control.

REFERENCES: DoD Laser Master Plan Volume II, August 2, 2000. ODUSD (S&T)/WS LMP Vol-II, 22 September 2000

KEYWORDS: Laser, beam director, beam control, optics, sensors, gyros, gimbals, stabilized platforms.

N03-071 TITLE: Broadband Processing for Mine Warfare Sonar

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS 490, Surface Mine Warfare Systems Program Office

OBJECTIVE: This SBIR project will develop a set of robust broadband signal processing algorithms to improve the ability of the AN/SQQ-32 to detect and classify mines while rejecting non-mine objects.

DESCRIPTION: This SBIR project will develop and demonstrate algorithms that exploit the frequency dependence of broadband acoustic signals to improve the mine detection and classification performance of the AN/SQQ-32 sonar. This improvement will be measured by the change in the sonar's Receiver Operating Characteristic (ROC) curve, which relates the probability of detection and correct classification to the probability of false alarm. The research emphasis in Phases I and II is on the physics-based signal processing required to robustly separate valid target detections from clutter, rather than on the systems engineering and "knobology" required to integrate these algorithms into the AN/SQQ-32.

Technical Goals: Among the technical goals of this research are:
1. Demonstrate the value (or lack of value) of these elements with regard to the mine detection/classification problem:
a. Broadband signals and signal processing.
b. Spectral weighting
c. Adaptive filtering
2. Quantitatively detail the performance tradeoffs involved with increased bandwidth.
3. Identify and investigate broadband signal processing algorithms to improve SQQ-32 mine detection and classification.
4. Determine the increased performance theoretically possible with any algorithms proposed.
5. Develop robust physics-based classification statistic(s) usable by the sonar system operator for reliable classification of mines vs. clutter.

Technical Background: The use of broadband signal processing to counter reverberation is a well-known technique in active sonar [Refs. 1, 2]. And properly accounting for variations in signal, noise and reverberation as a function of frequency, as required by detection theory, is especially important when using broadband signals [Refs 2, 3, 4, 5]. Such filtering or spectral weighting allows a system to automatically emphasize the parts of the spectrum with high signal-to-noise ratio and deemphasize those parts with little signal content, potentially adding on the order of 10 dB to system performance [Ref. 6]. However, the highly variable nature of reverberation prevents us from determining its spectral characteristics a priori. Instead, an adaptive approach is required [Ref. 7]. In addition, there is some evidence that targets and clutter may have differing frequency responses, providing an additional classification cue [Ref. 8].

PHASE 1: Determine the feasibility of using the AN/SQQ-32 in a broadband mode and perform a preliminary identification of the potential for improved performance from a) broadband processing, b) spectral weighting and c) adaptive filtering.

PHASE 2: Fully evaluate the value from a) broadband processing, b) spectral weighting and c) adaptive filtering. Develop innovative algorithms for the AN/SQQ-32 minehunting sonar for both detection and classification. Demonstrate the performance of a non-real-time prototype signal processor using recorded sonar data.

PHASE 3: Integrate the signal processing algorithms developed in Phase II into an AN/SQQ-32 sonar and participate in an at sea test against a selected set of mine targets.

Commercial Potential: Work vehicles for the oil industry to maintain and/or repair underwater pipes. Underwater object location and recovery. Unexploded ordnance identification, neutralization and mitigation.

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KEYWORDS: broadband; shallow water; reverberation; mine warfare; detection; classification

N03-072 TITLE: Strong Torpedo Fiber Optic Communications Link

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: ACAT II, PEO(SUB), PMS 404

OBJECTIVE: Develop an affordable strong Fiber Optic Micro Cable (FOMC) capable of paying out from torpedo tubes on underway Submarines to connect to buffered fiber that is payed out from a torpedo.

DESCRIPTION: There are inherent advantages in using fiber optics as the communications link between Submarines and Torpedoes to provide midcourse control. A fiber optic link, consisting of a dispensable coiled fiber optic package on the ship side and a dispensable coiled fiber optic package on the torpedo side would replace the low bandwidth, two coil, .03 inch diameter wire guidance communication system that now exists between the submarine and a launched torpedo, offering significantly greater bandwidth for post-launch ship-torpedo communications.

The increased bandwidth provided by fiber optic technology would enable torpedo data fusion with the submarine while the reduced size and weight of the fiber optic coils would provide benefits toward increasing torpedo payloads as well as increasing exercise endurance. Additionally, this would enable the torpedo to become a valuable system component in multi-platform scenarios associated with the battlespace strategies that are being addressed as part of the Navy’s Future Naval Capabilities (FNC) thrust.

To date several initiatives to replace the wire link with fiber optic technology have been pursued.

In the early 1990’s a .03 inch diameter Fiber Optic Micro Cable (FOMC), specifically developed for the torpedo-ship application was successfully dispensed at high speeds from both ship and torpedo locations during a high bandwidth communication demonstration involving a US Submarine and several Mk 48 Mod 4 torpedoes. This high strength cable (30#) consisted of a single mode, low optical loss, buffered fiber encased in an epoxy reinforced Fiberglas matrix having a resin overcoat. The FOMC design that evolved from this torpedo effort was subsequently patented by the U.S. Navy (U.S. Patent No. 5,440,660).

While the FOMC design can provide the strength and the reliable high speed dispensing (payout) performance required by the application, at a cost of $.35 per foot and a yearly Navy material requirement estimated to be as high as forty million feet, the cable is too expensive to be considered a viable, high bandwidth communication option that could economically replace a guidance wire that is approximately one tenth that cost.

More recently, the Applied Research Laboratory Of Pennsylvania State University (ARL/PSU) under an Office of Naval Research (ONR) sponsorship has been developing a low cost, small diameter (.005 inches), low tensile strength (8#), buffered fiber optic link option that has shown promise during in-water testing for the torpedo side of the link. The fiber design employs single mode, depressed cladding, small diameter (.010 inch), buffered telecommunications fiber (no strength components) that is commercially available from suppliers such as Alcatel, Corning, Furukawa and, Lucent. To date however, development activity has focused exclusively on the torpedo side of the system. Hence no design, development or testing of a similarly configured shipboard side of the dual coil fiber optic link has been pursued. While the ARL/PSU torpedo approach offers potential as a low cost fiber optic approach for the torpedo side of the system, it's low tensile strength characteristics are not appropriate for the high tensile stress conditions prevalent when a torpedo is submarine launched (impulsed) and the ship side of the link must remain intact while the submarine is free to maneuver.

Hence the challenge remaining is to develop a fiber optic link that is rugged enough to withstand deployment from the submarine torpedo tube through a flex hose like system at a reasonable cost for the yearly quantities required.

What is desired is a less expensive construction providing the strength to survive the torpedo launch transient that can be mated to the buffered fiber torpedo link.

PHASE I: Survey the fiber optic cable industry to determine what commercial-off-the-shelf (COTS) strong fiber optic cable designs, and manufacturing concepts, techniques, processes and approaches exist that could provide a more cost effective, creative design alternative to the Fiber Optic Micro Cable previously developed by the U.S. Navy. Additionally, develop several innovative fiber optic cable design structures that preserve FOMC-type performance while at the same time appreciably reduce its cost of manufacture in high volume order procurement scenarios. Hence both strengthen COTS cables and/or the development of new feasibility concepts based upon prior research with emphasis on affordability should be the primary focus of this phase.

PHASE II: Research samples of candidate constructions and subject them to laboratory tests for communications performance, optical packaging loss, bend radius, tensile strength, extended water immersion, deep depth capability, splicability, coil winding and high speed dispensing, cost effective manufacturability etc. Down select to two candidates and fabricate several test coils suitable for laboratory and at-sea testing.

PHASE III: Develop required changes to the submarine payout system to facilitate use of these configurations. Conduct Laboratory tests to identify design performance and down select to one candidate prototype. Develop the required documentation to support Navy acquisition of this technology into the Mk 48 Torpedo Mounted Dispenser. Produce approximately 100 systems for in-water test and evaluation. Since torpedo communications link usage is very limited it is anticipated that small business will be the supplier of choice for these expendable systems forever.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is a potential commercial market for cost effective strong fiber optic micro cables in communications and networking. There are other military applications in weapon/vehicle telemetry (e.g. UUV), mines and guidance and communications where cost effective strong fiber optic micro cables would be an advantage.

KEYWORDS: Communications link, Fiber Optic, Strong Fiber Optic Cables, Underwater Communications, High Speed Dispenser, Coil Winding, Coil Packaging, Optical Packaging Loss, High Tensile Strength, Extended Water Immersion, Fiber Optic Micro Cable, Post Launch Guidance, Torpedoes, cost effective manufacture, manufacture process improvement.

N03-073 TITLE: Submarine Emulsified and Mixed Hydraulic Oil Cleaning, Filtration and Reuse Aboard Ship

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT I (Submarine Program Office PMS392)

OBJECTIVE: Research and integrate innovative equipment, techniques, tooling and processes for use aboard ship to filter emulsifying and non-emulsifying mixed fluid hydraulic oils critical to platform control surfaces, periscopes and masts, and various outboard equipment motion control. Navy submarines are presently experiencing excessive Fleet material casualties related to hydraulic oil contamination, component failures, pre-mature system fluid replacement and high disposal costs. The technical objective of this SBIR is to deliver equipment to the Fleet that is capable of the batch restoration of hydraulic fluid to a particulate level of 0.50 micron absolute, and a maximum saturation level of 0.05 percent water.

DESCRIPTION: Navy ships use various petroleum oil based hydraulic systems to control critical ship maneuvers and provide essential motive power to high priority component loads located inside and outside of the ship. Selected hydraulic systems that have a seal interface or exposure to sea water experience easily degraded conditions related to oil contamination. Navy submarine hydraulic systems routinely encounter high levels of salt water contamination of the system fluid. Effective filtration of water emulsifying and mixed hydraulic fluids is very difficult since the Navy has been unable to identify either government or commercial devices that perform this task. Fluid replacement and disposal of used hydraulic oil is very costly and time consuming. This SBIR effort would exploit parts of existing commercial and patented technologies to construct portable equipment that could be used aboard ship in closely confined areas by ship operators underway, and by skilled maintenance personnel in port. Navy submarine hydraulic systems presently perform continuous in-service filtration for particulates at the level of 10 micron nominal. Navy submarine hydraulic systems do not presently have continuous in-service dehydration capability.

PHASE I: Research the technology, develop and assemble prototype devices, equipment and physical techniques to effectively filter contaminated emulsifying and mixed non-emulsifying hydraulic oils. This equipment must be assembled into a portable system that is of a sufficiently small configuration that it can be moved and operated by one man in tightly confined shipboard conditions. The portable filtration system must contain devices to instrument, power, display and collect data, control flows, and store hydraulic oils and contaminants removed from the shipboard systems. Complete and demonstrate this phase in a industrial shop/laboratory environment before moving to a Navy tactical platform.

PHASE II: Develop a fully functional portable filtration system that has performed with a sufficient degree of engineering safety and performance certainty that it will function in the rigorous environment of a Navy ship engineering plant underway. Provide full documentation of the techniques, equipment and process used to operate this filtration equipment.

PHASE III: Prepare a complete descriptive engineering data package needed to reproduce and market this portable filtration system to Government and commercial activity customers worldwide. This completed package must be constructed so that a finished filtration system can be easily manufactured under competitive bid process utilizing "commercial off the shelf" (COTS) or readily available sub assemblies purchased in the open marketplace.

PRIVATE SECTOR COMMERCIAL POTENTIAL:

1. Commercial Marine Industry - Marine Break/Bulk Carrier, Container Shipping, Coastal & River Craft/Tug Boats, Cruise Passenger Ship, Commuter Ferries, Port/Land Facility Heavy Cargo Handling Equipment Operations.

2. Waste Oil Environmental Recovery Operators - Bulk Used Industrial Oil Processing & Safe Disposition, Hazardous Spill Clean-up and Restoration Activities.

REFERENCES: National Fluid Power Association, Hydraulic Institute, Fluid Power Society, OilAnalysis.com (Noria Corporation, Tulsa, OK).

KEYWORDS: Hydraulic Fluids, Workload Reduction, Maintenance Effectiveness, Environmental Recovery.

N03-074 TITLE: <u>Development of a Supportability Performance Assessment System for Training Systems</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMS411, AN/SQQ-89(V), ACAT IC

OBJECTIVE: Enable training developers and instructors to better monitor and assess training lesson and overall curriculum effectiveness. Develop tools to collect, monitor, and analyze human interaction information from a training or tactical system involving individual or coordinated teams.

DESCRIPTION: The Navy is currently involved in the requirements definition phase for the Chief of Naval Operation's (CNO's) Revolution in Navy Training, as part of the Task Force for Excellence through Commitment to

Education and Learning (EXCEL). The goal of Task Force EXCEL is to continuously measure and adapt training systems, where the sailor's professional growth and development is the focus of the educational system, not the training hardware assets. The ability to factor feedback on training curriculum effectiveness into the training/system development process can be as important as the effectiveness of the training system itself. By using a Human Performance System Model as an approach, Task Force EXCEL will transform Navy training to become performance based. This project will develop a Supportability Performance Assessment System that will allow training system developers to analyze alternate training approaches and influence both the curriculum and training systems updates. It can also be used as a tool to improve tactical system operator machine interfaces by assessing student comprehension of tactical system concepts of operation. This effort would support the Task Force EXCEL initiative by developing a system for monitoring trainee performance as an individual or in a team environment, and using this as feedback to the training curriculum development process.

PHASE I: Perform a requirements analysis and develop a system design for a system training performance assessment system. This system would use passive monitoring techniques to evaluate student interactions with simulated tactical situations in both a standalone and team environment.

PHASE II: Prototype a training system technology demonstration to allow evaluation of performance assessment and feedback approaches. Develop metrics for assessment of training effectiveness to be monitored following system implementation.

PHASE III: Develop a modular supportability performance assessment system that can assess human interaction and team performance.

COMMERCIAL POTENTIAL: This system could be applied in any work environment involving training effectiveness evaluation, mentoring, or team interaction.

REFERENCES: Task Force EXCEL, http://www.excel.navy.mil/.

KEYWORDS: Training, performance, assessment, human, task

N03-075 TITLE: <u>Development of an Advanced Thermoelectric Cooling System for Unmanned Underwater Vehicles (UUVs)</u>

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: ACAT II: PMS 403- Mine Undersea Warfare- Unmanned Undersea Vehicle

OBJECTIVE: Address the engineering challenges that exist in taking results of recent advancements in thermoelectric (TE) materials research and creating an effective cooling system for use in unmanned underwater vehicle applications.

DESCRIPTION: The US Government, through several of its agencies (DARPA and ONR for example), has invested resources into the development of materials that will make solid state heat pumps and generators (so called thermoelectric devices), which generate either heat flow under an applied electric current or electric current under an applied heat flow, technically and economically competitive with other mechanical systems. The benefits of TE devices have traditionally been limited to applications where space is a premium and where cooling or generator loads are small. With the development of new materials that improve the thermoelectric figure of merit, it is expected that TE devices can be used in situations where mechanical solutions have been traditionally employed. This project will take the results of recent thermoelectric material developments and transition them into a practical cooling system. The unmanned vice manned vehicle is an ideal platform to initiate the development of an advanced thermoelectric cooling system that can addressed the issues with respect to humidity, power consumption, and radiated noise. Electrical power on a UUV is a limiting resource, there is much to be gained from the introduction of an alternative cooling system that potentially uses less power. Additionally, eliminating mechanical devices (i.e. fans) would be to reduce the vehicles self-noise signature, critical in clandestine missions. Finally, the engineering tools used to model a thermoelectric device as a component in a complete heat transfer problem need to be developed for an undersea application environment. Currently, the LMRS UUV utilizes approximately 30 watts of power to cool the vehicle control processor and power distribution unit.

PHASE I: Develop a conceptual system and design approach for a cooling system operating in the target platform environments. Demonstrate a Coefficient of Performance (COP) as good or better than a cooling system typically used on a UUV. Develop the modeling tools needed to design a detailed cooling system.

PHASE II: The design from PHASE I will be developed into a working cooling system, which will be installed on a suitable existing UUV platform. Performance characteristics (cooling system power consumption, vehicle range, internal temperature, etc) will be compared between the vehicle before and after conversion to the advanced cooling system. The test platforms can be the future 21" MRUUV or other 21" diameter test vehicles (both electric and OTTO fuel) that could be made available and instrumented (Note: this method may also be useful for torpedo applications).

PHASE III DUAL USE APPLICATIONS: A practical TE device based cooling system will have uses in numerous defense (Ships, UUVs and Torpedoes), and commercial (automotive and residential) cooling systems. They are an excellent fit with the Navy's desire for an "all electric ship".

REFERENCES:

1. CRC Handbook of Thermoelectrics. DM Rowe (editor). University of Wales College of Cardiff, U.K. , July 1995.

2. "Thin-film thermoelectric devices with high room-temperature figures of merit". R. Venkatasubramanian et al., Nature, Vol 413, 11 Oct 2001 pp597-602.

KEYWORDS: Thermoelectric, Peltier effect, solid-state, cooling, electronics, and refrigeration.

N03-076 TITLE: <u>Advanced Digital Array Radar (DAR) Adaptive Beamformer and Pulse Compression Processor</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO for Theater Surface Combatants, Radar Systems Division (PMS 426)

OBJECTIVE: Develop new signal processing technologies that can execute real time wideband adaptive beamforming and pulse compression algorithms. New technologies must emphasize a minimization in volume and power and be reprogramable to support future improved algorithms.

DESCRIPTION: DAR sensors will function as the primary detection mechanism for ballistic missile and air breathing threat defense applications, providing early warning of attack, target detection/classification/identification, target tracking, and kill determination. New and innovative approaches to implementing the high throughput signal processing necessary to provide the advanced capability are sought. Candidate approaches must take into consideration the ease of design, design reliability, maintainability and portability, fault tolerance and technology refresh strategies and the requirement that future algorithm upgrades be supported without replacing hardware. Entirely new and high-risk approaches are also sought.

PHASE I: Develop concepts and design approaches that substantiate an achievable, highly parallel signal processing technology. Identify nominal radar and background characteristics that will be used to establish performance guidelines. Fully describe the theory of operation of the new signal processing technology. Provide a detailed description of how the new technology will support data reorganization. Provide analysis showing conceptual performance characteristics and compare to a software based approach using programmable general purpose signal processors.

PHASE II: Design, build, and test a prototype system based on the technology of Phase I. Based on the nominal radar and background characteristics used in Phase I, show the ability to perform adaptive cancellation of multiple interfering signal sources and perform multi-channel pulse compression. Identify performance in terms of throughput, latency, power consumption, and processing density.

PHASE III: Transition to advanced development of a full-scale design and production processor.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These technologies could be applied in many RF applications such as the cell phone industry, commercial airport radar systems, and automotive industry.

REFERENCES:

1. Walke, R.L.; Smith, R.W.M.; Lightbody, G., "Architectures for adaptive weight calculation on ASIC and FPGA ", Signals, Systems, and Computers, 1999. Conference Record of the Thirty-Third Asilomar Conference, Volume: 2 , 1999, pp. 1375 -1380 vol.2

2. Chung-Yao Chang; Shiunn-Jang Chern, "Adaptive linearly constrained inverse QRD-RLS beamformer for multiple jammers suppression", Wireless Communications, 2001. (SPAWC '01). 2001 IEEE Third Workshop on Signal Processing Advances, 2001, pp. 294 -297

3. Song, W.S.; Baranoski, E.J.; Martinez, "One trillion operations per second on-board VLSI signal processor for Discoverer II space based radar", D.R.,Aerospace Conference Proceedings, 2000 IEEE , Volume: 5 , 2000 Page(s): 213 -218 vol.5

4. Bollini, P.; Chisci, L.; Farina, A.; Giannelli, M.; Timmoneri, L.; Zappa, G., "QR versus IQR algorithms for adaptive signal processing: performance evaluation for radar applications", Radar, Sonar and Navigation, IEE Proceedings , Volume: 143 Issue: 5 , Oct. 1996, pp. 328 -340

5. Andraka, R. and Berkun, A., "FPGAs Make a Radar Signal Processor on a Chip a Reality", Proceedings of the 33rd Asilomar Conference on Signals, Systems and Computers, October 24-27, 1999, Monterey, CA.

KEYWORDS: radar; algorithms; beam forming; antenna array; signal processing; digital array radar

N03-077 TITLE: Advanced Engineering Application Integration Technologies

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO for Theater Surface Combatants, Aegis Open Architecture (PMS 400-B)

OBJECTIVE: Develop a means for establishing and maintaining traceability, consistency, and tracking data dependencies across many domains and stove pipes created by the broad spectrum of engineering tools in use on large complex system programs. Reduce integration costs and increase flexibility to meet specific needs within a project as well as changing needs as new tools and processes are introduced.

DESCRIPTION: Engineering applications (e.g. system requirements, software design, test, logistics, and cost) typically have their own data representations, file formats, application interface and often their own internal database. With few exceptions there is limited interoperability for establishing consistency and traceability across the data managed by these tools. Building and maintaining point-to-point translators between applications is expensive and usually specific to a particular process or use within a project and therefore not very flexible or adaptable to new projects or changes within existing projects. A common object-oriented engineering data repository solution which takes advantage of advanced data modeling techniques has significant promise however it must support industry data standards, address data translation to and from tools, and provide discovery of repository capabilities, distributed communication and notification mechanisms. The solution should also address issues with communicating semantically, not just syntactically, supporting varying levels of abstraction and detail of data/information representations.

PHASE I: Develop an approach for development of a common object oriented data repository distributed framework and demonstrate feasibility through testing of critical items.

PHASE II: Develop and test a full-scale prototype of the repository involving at least three applications having overlapping capabilities/uses but varying data representations.

PHASE III: Transition the full-scale prototype to pilot projects in selected commercial and government programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This object-oriented repository could be applied in a of spectrum complex data management areas including commercial (e.g. manufacturing) and government (e.g. program management)

REFERENCES:

1. MIL-STD-1472, DoD Design Criteria Standard: Human Engineering

2. MIL-HDBK-759, Human Engineering Design Guidelines

3. MIL-HDBK-46855-Human Engineering Guidelines for Military Systems, Equipment, and Facilities

KEYWORDS: Automation; tool integration; distributed communication; traceability; data dependencies; object-oriented

N03-078 TITLE: Metal Passivization to Resist Corrosion

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Aegis New Construction Program Office, PMS 400D

OBJECTIVE: Develop a portable, environmentally-friendly and high quality localized anti-corrosion system to provide passive protection such as galvanizing or nitriding of steel structural features of limited spatial extent and difficult to access for maintenance, commonly associated with manufacturing processes such as joining, fastening and welding.

DESCRIPTION: Localized corrosion of painted steel structures often initiates at manufacturing or maintenance irregularities associated with metal joining, cutting or extreme forming. The restoration or introduction of highly controlled passive protection is viewed as a means of reducing or eliminating maintenance activities associated with painted steel structures.

Electrolytic processes have been used for some time to deposit metallic alloys onto metal surfaces. Technological advances now allow the possibility of cleaning and coating metallic substrates in one operation. This technology also allows coatings of materials that were previously thought unable to be coated, such as lead. Examples of articles that have been processed through this technology also exhibit significant improvement in adhesion of the materials deposited on the substrate, performing far better than traditional cold or hot galvanizing processes.

This technology holds much promise to supply a method to move away from currently applied preservation management systems that are predominantly polymer based. Preservation systems based on polymers cause many problems in shipbuilding because they perform poorly when heat is applied. Normally, only a small amount of heat needs to be applied to a polymer system to cause disruption and failure. In shipbuilding, with constant welding, cutting and other assembly and fabrication activities, failures of the preservation system are common and rework can become an onerous task.

Electrolytic processes hold potential to replace polymers with materials (alloys) that react to heat much the same as the steel substrate does. This could minimize or eliminate many problems experienced today with existing preservation management systems.

Problems areas of interest include edges of stiffener flanges, cut plate edges, erection joint welds.

PHASE I: Establish feasibility of metal passivization process best suited to fabrication, assembly and maintenance of ships. Provide a comparison of with current polymer coating systems along with a thorough cost model of recurring and non-recurring expenses for the selected process.

PHASE II: Develop materials infrastructure, deposition equipment and control systems for incorporating selected passivization process at the point of manufacture and/or in maintenance facilities. Demonstrate passivization technology in ship construction environment. Ensure passivization process does not adversely affect fire, smoke and toxicity requirements as well as the material mechanical properties. Provide a set of recommended tests to include: Fire, Smoke and Toxicity (MIL STD 2031; Mechanical Properties (MIL-STD-1689).

PHASE III: Implement selected passivization process into fabrication, assembly and maintenance of ships. Introduce this technology to other federal agencies for application to aircraft, armored vehicle, other land vehicles, and engineering metal structures.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology has the potential for wide utilization in such diverse areas as automotive systems, infrastructure protection, agricultural and consumer products.

REFERENCES:

1. MIL-STD-2031, Fire Smoke and Toxicity

2. ASTM-E884, Cone calorimeter Test

3. Salt, Spray Aging Test

4. MIL-STD-1689, Structural Mechanical Properties Test

KEYWORDS: passivization; electrolytic; galvanizing; steel; corrosion; protection

N03-079 TITLE: High Performance Secure Shipboard Network For Wireless/Wired Connectivity

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO for Theater Surface Combatants, Smartship (PMS 400F8)

OBJECTIVE: Develop innovative enabling security technologies/approaches/systems/ processes to enable secure high performing shipboard use of wireless sensors, computers, devices and applications that transmit data/information via RF/IR over wireless/wired LAN (WLAN)

DESCRIPTION: Commercial applications of wireless radio frequency (RF) LANs, RF/IR sensors, devices and computers have matured extensively over the past several years. Navy wireless information technology (IT) systems are being developed for logistical, personnel, and maintenance-related systems. Shipboard wireless systems offer simplified adaptability for COTS technology refresh over long shipboard lifecycles and are particularly applicable for collecting system data/information from multiple remotely located systems and for mobile access to computer networks.

The Navy must operate in foreign seas and ports where secure communication is important for even unclassified transmissions. Secure communication is one of the primary limitations of current commercial wireless LANs.

The Navy is interested in innovative high performance low cost security methods that are consistent with industry standards. VPN is one method to assure security, other methods are also encouraged, such as the use of programmable DSP chips, and industry standard protocols.

Innovative security solutions that minimize performance degradation would enable the Navy to use commercial wireless LANs, devices and applications. An objective of this initiative is to enable wireless devices that transmit via RF or IR to communicate securely over a WLAN/LAN without compromising bandwidth and throughput. Navy WLANs are often integrated with wired LANs, hence solutions that operate on both WLAN and wired LANs are desired. AT a minimum the solution should perform at FIPS 140-1 or 2 standard.

Solutions that balance affordability, security and performance are strongly desired. Use of IEEE & other Open System Architectures standard interfaces is essential to enable increased shipboard exploitation of commercial systems (COTS) over long ship lifecycles. A solution that considers classified and non-classified transmissions is important.

PHASE I: Develop concept for affordable, innovative wireless enabling technologies/approaches/ systems/processes that result in secure and high performing WLANs and wired LANs. Provide software model that demonstrates the potential of the VPN concept. Provide cost saving and performance metrics. Provide how solution is different from other commercial solutions. Provide report that details the concept, metrics and life-cycle costs.

PHASE II: Analyze and demonstrate through a prototype system the feasibility of approach developed in Phase I in both laboratory and shipboard environments. Document approach and impacts on capability, acquisition, installation, and lifecycle costs. Demonstrate security and performance approaches under multiple scenarios simulating operational conditions to evaluate capability. Provide cost saving and performance metrics (more fidelity and accuracy than in Phase I). Provide report that details the concept, metrics and life-cycle costs.

PHASE III: Develop transition plans and demonstrate the commercial and shipboard use of approach. Build ship ready system that can be demonstrated at sea on Navy Ship. Demonstrate, Security and approaches under multiple scenarios simulating operational conditions to evaluate capability, security, and electromagnetic interference/compatibility. Perform and document, lab, pier-side and at sea testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Wireless technology represents one of the fastest growing sectors of the IT market. Wireless LANs and devices are in use in a number of commercial applications including industrial plants, office buildings, universities, etc. Security remains one of the weakest areas of current IEEE standards and industry solutions. Solutions that provide high security and high performance at an affordable cost for shipboard use are easily transferable to land-based use. Security and Open Systems Architecture interfaces are especially prevalent concerns in the commercial market.

REFERENCES:

1. EETIMES, 6 August, 2001. Cipher attack delivers heavy blow to WLAN security. Website: http://www.eetimes.com/story/OEG20010806S000

2. University Maryland, March 2001, Your 802.11 Wireless Network has No Clothes. Website: http://www.cs.umd.edu/~waa/wireless.pdf

3. ISNS PPL/QPL Test Report: "Wireless Local Area Network (WLAN)", August 31 2000, SPAWAR, Rev 2.1, Integration Test Facility, SSC SD.

4. USS The Sullivans Wearable PC and Wireless LAN Electromagnetic Interference and Threat Analysis Test Report, 15 October 1998, PEO Theater Surface Combatants, PMS-400F7.

KEYWORDS: Wireless; Network; LAN; WLAN; Security; architecture

N03-080 TITLE: Radome Materials & Process for Long Flight Duration-High Speed Missiles

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO, Theater Surface Combatants, Standard Missile Program Office (PMS 422)

OBJECTIVE: Develop ceramic or inorganic polymer radome materials capable of surviving the extreme environment of next generation, long duration flight, supersonic and hypersonic missiles. Radome materials shall be of low dielectric constant and exhibit a loss tangent adequate for high performance radomes.
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DESCRIPTION: New technology is needed to improve radome performance, durability and structural integrity. Missile acceleration, speed and range increases required to meet advanced threats result in increased thermal shock, thermal loading, and rain erosion. Materials with the properties required for future high performance missiles do not currently exist and often when new materials are developed they are expensive to manufacture. This topic solicits innovative material combinations (particularly fiber reinforced materials) that have the desired properties and creative methods by which they can be cost effectively manufactured.

PHASE I: Identify candidate materials and innovative technologies that may be suitable for developing a new generation of radomes. Application of fiber or whisker reinforcement technology to existing or emerging ceramic or inorganic polymer materials should be considered as well as any other innovative technologies that may be applicable. Address structural, thermal, electrical, and environmental properties. Summarize cost, risk and performance on for all materials recommended for further development.

PHASE II: Fabricate specimens of radome material. Demonstrate material characteristics to include properties that affect radome performance physically, structurally, thermally, and electrically. Measurements at temperature will be performed.

PHASE III: Prototype radomes will be fabricated and tested.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial industries such as gas turbine power generators or engines will benefit from materials for placement in high temperature sections of the turbines. Utilization on commercial aircraft as turbine blades or in hot gas exhaust areas will reduce the weight and cost of the typical steel components. The ballistic body armor industry can use this technology to reduce the weight of bullet resistant garments used by police. The electronics industry will benefit from the lower dielectric constant of the proposed material, which could replace high dielectric alumina in high-heat-load, surface, mount technology electronics.

REFERENCES:

1. http://www.fas.org/man/dod-101/army/docs/astmp/c4/P4P.htm

2. http://www.dtic.mil/mctl/DCT/Sec1PtIII.pdf

KEYWORDS: Radome; Ceramic; Whisker; Fiber; Composite; Alumina; Silica

N03-081 TITLE: Uncooled Infrared Focal Plane Array (IR FPA) Window

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Future Theater Air & Missile Defense (PMS 456)

OBJECTIVE: Develop an uncooled window for an infrared focal plane array (IR FPA) sensor suitable for use in the high aerothermal environment.

DESCRIPTION: An infrared focal plane array (IR FPA) sensor on an extended range surface to air missile has tremendous potential for engagements of challenging threats. An IR FPA sensor can detect incoming threats at significantly long ranges and with very small angle errors. This combination of larger detection ranges and small angle errors can result in small miss distances and hence enhanced percent kill (Pk). However, there is cost and technical complexity associated with the required cooling system for current IR windows. The current IR window material must be cooled to operate in the high aerothermal environment. A very attractive alternative for an IR sensor is an uncooled IR window, which can operate in the high aerothermal environment of a surface-to-air missile. There have been pervious technology investigations into uncooled IR windows in industry and at universities. However, these efforts are fragmented and minimally funded, if at all. A single coordinated uncooled IR window technology program is necessary to leverage off of the existing work and to focus the effort on cost effective engagements.

PHASE I: Demonstrate the likelihood that a new and innovative research and development approach is worth pursuing.

PHASE II: Develop a prototype window that demonstrates feasibility using a focal plan array under simulated.

PHASE III: Integrate new and innovative window with focal plane array seeker and demonstrate working prototype in a simulated high aerothermal environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There will undoubtedly be technology transfer to the commercial IR industry. The private sector will certainly profit by marketing this technology back to the government.

REFERENCES:

1. http://www.wslfweb.org/docs/dstp2000/jwstppdf/09-jtmd.pdf

2. "IR-window design for hypersonic missile seekers: thermal shock and cooling systems", S. Körber, U. Hingst, Bodenseewerk Gerätetechnik GmbH (Germany)

KEYWORDS: Infrared (IR); Focal; Array; Tactical; Ballistic; Missile

N03-082 TITLE: <u>Electronic Sensor Precision Feature Extraction Pre-processor</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO Theater Surface Combatants, PMS 473: Electronic Warfare Systems Div

OBJECTIVE: Develop novel low cost electronic support measure (ES) pre-processor to extract radar signal parameters and significantly reduce data load in measuring standard and non-standard radar emission parameters.

DESCRIPTION: An Electronic Sensor Precision Feature Extraction Pre-processor would greatly improve precision measurement of intercepted radar emission parameters. New mathematical algorithms appreciably enhance sensor sensitivity, signal detection, frequency measurement, time-of-arrival accuracy, pulse width measurement, and amplitude measurement. With these parameters, classical electronic sensor data can be precisely calculated. Mathematical algorithms provide new methods for analyzing intra-pulse modulations: chirp, digital phase shifting, and special modulations.
Development effort should emphasize digital signal processing (DSP) methods that will significantly improve the accuracy of parameter measurement compared to existing ES systems and at a much lower cost. The design/algorithms should provide high receiver sensitivity for long-range signal detection, as well as traditional and special parameter extraction capabilities.

PHASE I: Develop design for a novel feature pre-processor technique/algorithm. Include all DSP algorithms and methods to provide the parameters stated in the description. Because amplitude dynamic range is very important for any ES sensor, a method to provide a useful system dynamic range will be explored.

PHASE II: Develop the feature extractor and measure its parameter precision.

PHASE III: Develop the feature extraction device into a highly sensitive ES sensor in order to operate in a shipboard environment. Develop shipboard RF environment control and filtering techniques. Interface and integrate to existing shipboard combat systems. Integrate existing software algorithms for identification.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial aircraft and high-value cargo ships could use this sensor for improved collision avoidance. Maritime police could use a highly sensitive sensor against boats that ship contraband. The sensitive detection techniques could be used by the automobile industry for collision avoidance.

REFERENCES: John N. Little and Loren Shure, Matlab Signal Processing Toolbox, The MathWorks, Inc.

KEYWORDS: Radar; Parameter; Measurement; DSP; Frequency; ESM

N03-083 TITLE: Wideband Limiter Protector for radar and electronic warfare systems

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS 473: Electronic Warfare Systems Div., PMS 426: Radar Systems Division

OBJECTIVE: Develop wide-bandwidth high-power receiver front-end protection devices for future advanced radar and electronic warfare systems.

DESCRIPTION: Future Navy radar systems require high power levels per array element, and per array. Unheard of power levels, both within the radar and external to it must be accommodated without degrading or destroying the radar itself or nearby RF systems. Emissions from nearby shipboard radar systems can destroy sensitive ES system front-end amplifiers. To allow ships to simultaneously operate powerful radars and advanced electronic warfare systems, advanced receiver protectors are required. There is a pressing need for advanced capability receiver protection devices for future RF systems both at L, S, X, and Ku bands.

PHASE I: Identify potential new and innovative research and development approaches to meet the high power limiter needs discussed in this topic.

PHASE II: Develop applicable and feasible prototype demonstrations and/or proof-of-concept devices for the approach described, and demonstrate a degree of commercial viability.

PHASE III: Develop pre-production and production components and sub-systems for integration into Navy surface combatants.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial and military aircraft can easily come within range of powerful radars that could damage their detection systems.

REFERENCES:

1. Tsui, J, Digital Techniques for Wideband Receivers, Artech House, 2001.

2. Vizmuller, P, RF Design Guide: Systems, Circuits, and Equations, Artech House, 1995.

3. Chang, K, Microwave Solid-State Circuits and Applications, Wiley, 1994

4. Vaccaro, D., Electronic Warfare Receiving Systems, Artech House, 1993

KEYWORDS: Emitter; EW; radar; ES; limiter; switch

N03-084 TITLE: Radar Power Sources and Power Conditioning

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO for Theater Surface Combatants, Radar Systems Division (PMS 426)

OBJECTIVE: Advance the state-of-the-art of DC-to-DC power conversion technology as applied to radar antennas.

DESCRIPTION: The cost and weight of DC-to-DC power conversion and related technologies for RADAR antennas are critical for today's high power Radars. The continued development of increasingly robust and sophisticated power conversion technologies is critical to the ballistic missile technology program and other major defense acquisition programs. Furthermore, RADAR prime power conversion systems, components and sub-components are constantly under review for upgrade from industry to reduce cost and/or weight. Higher power levels of future Navy radar antenna systems require state-of-the-art capabilities to achieve reductions in the antenna's weight, size, and cost. Advancements are required in the development of power conversion related technologies including lower cost and/or weight DC to DC converters, energy storage, magnetics, and switches applicable to projected shipboard requirements. Research or Research and Development efforts selected under this topic shall demonstrate and involve a degree of technical risk where the technical feasibility of the proposed work has not been fully established.

PHASE I: Determine feasibility of new and innovative research and development approaches to meet the power conversion needs discussed in this topic.

PHASE II: Develop applicable and feasible prototype demonstrations and/or proof-of-concept devices for the approach described, and demonstrate a degree of commercial viability.

PHASE III: Develop pre-production and production components and sub-systems for integration into Navy surface combatants.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These technologies could be applied in many power applications such as the telecommunications industry, commercial airport radar systems, and automotive industry.

REFERENCES:

1. E. R. Hnatek, Design of Solid-State Power Supplies, New York, Van Nostrand Reinhold Company, 1981.

2. Mohan, Undeland, and Robbins, Power Electronics: Converters, Applications, and Design, New York, John Wiley & Sons, 1995.

3. M. Brown, Power Supply Cookbook, Butterworth-Heinemann, Newton, MA, 1994.

4. Cuk, Advances in Switched Mode Power Conversion, pp. 279-310, Irvine, Taslaco, 1981.

5. R. W. Erickson, Fundamentals of Power Electronics, New York, Chapman and Hall, 1997.

6. R. Severns and G. E. Bloom, Modern DC-to-DC Switchmode Power Converter Circuits, New York, Van Nostrand Reinhold, 1985.

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KEYWORDS: radar; array; power; conversion; DC-DC; capacitor

N03-085 TITLE: Multi-Component / Integrated Pulse Analysis Display Capability For Electronic Warfare Systems

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Theater Surface Combatants, PMS 473 Electronic Warfare Systems Div

Objective: The objective of this research effort is to explore the feasibility of providing an integrated, multi-component pulse analysis capability that would be displayed and exploited for maximum potential into current Electronic Warfare (EW) systems.

Description: Current Electronic Support (ES) receiver suites intercept and evaluate radar signals. The EW operator uses parametric data to verify its proper identification. In some cases the system may incorrectly measure parametric data from complex radar systems due to front-end limitations. These false measurements can result in emitter classification errors. Real-time pulse processors give the EW operator an ability to visualize intercepted data and pick out traits of an emitter that may go undetected by the ES system, allowing the operator to make a more informed evaluation.

To compensate for these shortfalls, today's surface ship EW operators use additional systems to perform real-time pulse analysis, and ambiguity resolution. Currently, when the EW operator analyzes incoming signals, they must look at an ancillary display and may miss important tactical events. It is important that display data derived from the pulse processing subsystem be available to the EW operator and integrated into the tactical displays on the primary EW suite, enhancing the overall tactical picture.

Recent technologies have produced a wide range of capabilities focused upon specific missions and functions of EW, and while these technologies improve upon the shortfalls mentioned above, they are still independent solutions that remain uncoupled from primary, ES/EW suites.

The technical objective is focused upon the increased benefit of consolidating capabilities that are currently segregated to different hardware components. Specifically, advanced pulse processing techniques should be incorporated into a single EW suite such as the AN/SLQ-32, negating the need, cost, and maintainability of ancillary equipment (i.e. the ULQ-16, O-Scope, etc). The hardware/software interface should support both digitized and analog data formats to provide the greatest flexibility in meeting today’s and tomorrow’s pulse analysis and processing needs.

In addition, display formats that provide the level of detail required to fulfill signal analysis missions should be developed in a way that isolates them from the actual pulse processing. This allows for the incorporation of improvements in both precision and speed of pulse processing as technologies advance, without the need for display modifications that would require additional operator training.

PHASE I: Investigate current pulse analysis systems and associated software applications/tools to determine what functional component(s) provide the EW operator the best capabilities and how they can be integrated into current EW systems. Develop prototype windows and concepts of how these windows could be integrated into the displays of current EW systems in a manner to enhance the human machine interface (HMI).

PHASE II: Design and build a prototype pulse analysis subsystem that provides an integrated end-to-end application for improving ES/EW suites. Perform an HMI analysis of the integrated pulse analysis subsystem to determine if the EW operator's tactical picture is improved. Provide a demonstration of the prototype software / hardware.

PHASE III: Build and integrate a production quality, multi-component, pulse analysis subsystem that combines dissimilar system components into an existing ES/EW system.

Private Sector Commercial Potential: In addition to having specific Navy EW suites, COTS (Commercial, Off-The-Shelf) based signal analyzers are used in surveillance systems across all branches of the military, in the aerospace industry and in non-DOD areas of the government such as the Central Intelligence Agency (CIA) and the Federal Bureau of Investigation (FBI). One potential application within these agencies would be the use of an integrated pulse analysis / display subsystem to help track terrorist activity. Another potential application would be the use of multiple, highly accurate pulse analyzers to locate wireless emergency 911 callers using time difference of arrival algorithms.

REFERENCES:

1. Principles of Electronic Warfare: Robert J. Schlesinger, K. Abbey, R. W. Ehrhorn, K. J. Friedenthal, S. H. Logue, Peninsula Publishing, ISBN: 0932146015.

2. Introduction to Communication Electronic Warfare Systems: Richard Poisel, Artech House, Incorporated, ISBN: 1580533442.

3. “Ship Survivability And Electronic Warfare (EW)”, Arthur G. Self, Seminar Presentation, 1997.

4. Radar Handbook, Second Edition: Merrill I. Skolnik, Editor In Chief, McGraw-Hill Publishing Company, New York, 1990.

KEYWORDS: Pulse; Analysis; Signal; EW; ESM; parametric

N03-086 TITLE: <u>Permanent Magnet Motor Steering Gear</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Aegis New Construction Program Office, PMS 400D

OBJECTIVE: Demonstrate the reliability and suitability of modern motor and electronic drive technology for future replacement of variable speed hydraulic and steam turbine driven applications.

DESCRIPTION: Advances in Permanent Magnet Motor (PMM) technology offer the promise of a lower Life Cycle Cost alternative to expensive and maintenance-intensive hydraulic and turbine drives. As such the Navy has invested time and money toward the use of PMMs in a shipboard environment. An Engineering Change Proposal is being developed to install a Permanent Magnet Motor with a shaft and gearbox on an anchor windlass for DDG 103 and follow-on ships. The USS ROOSEVELT (CVN 71) currently has a permanent magnet motor capstan installation with a Variable Speed Drive (VSD). The purpose of this installation is to evaluate the operation improvement to the conventional capstan motors. This topic will focus on the application of the PMM technology to replace a large hydraulic system, the DDG Flight IIA Steering Gear System.

PHASE I: Conduct feasibility study and provide recommended configuration for a cost effective DDG 51 FLT IIA Steering Gear system using PMM technology. Provide detailed plan addressing design, installation and test costs. Selection of design for Phase II should also take into account both recurring and non-recurring engineering and life-cycle cost concerns such as development costs, maintainability, reliability, supportability to achieve a .99 availability along with weight, electric field, shock, etc.

PHASE II: Build land based prototype system and demonstrate scalability. Test in accordance with existing performance requirements for DDG 51 Steering Gear. Include tests for electric field, power consumption, manual back-up systems, and operation in the event of a loss of main power. Provide detail design drawings, system schematics, performance and cost analysis.

PHASE III: Conduct shipboard installation and at-sea test of pre-production prototype. Deliver a series-production plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The use of PMMs on a large scale directly translates to propulsion system improvements for the commercial maritime industry. This technology is directly applicable to steering of potted propulsors as well as rudder equipped ships and facilitates all electric propulsion.

REFERENCES:

1. MIL-STD-901D Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems Requirements.

2. Permanent Magnet Motor General Requirements Report, Newport News Shipbuilding, 4101 Washington Ave. Newport News, Virginia, 23607.

3. Engineering Change Proposal ECP 51-1493 Electro-Mechanical Anchor Windlass.

4. Electric Field Requirements; Testing Methods MIL-STD-461 and Systeml Interface MIL-STD-464.

5. DDG 51 and follow, Building Specifications, Section 561 Steering Systems.

6. Naval Ship's Technical Manual (NSTM) Chapter 562, Surface Ship Steering Systems.

KEYWORDS: PMM; VSD; Motors; magnets; steering; Electric

N03-087 TITLE: Rapid Deterministic Fault Detection in Distributed Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO for Theater Surface Combatants, Aegis Open Architecture (PMS 400-B)

OBJECTIVE: Develop a standardized implementation for rapid, deterministic fault detection.

DESCRIPTION: Commercially available distributed system management products can detect and isolate faults (e.g., inoperative nodes, faulty interfaces, etc.). Unfortunately, they do provide real-time performance with bounded detection latencies. Real-time distributed systems require both rapid and bounded latency fault detection mechanisms. This research would identify a set of principles, approaches, and techniques for extending, modifying, augmenting or interfacing to these commercial system and resource management products to facilitate their use in real-time systems.

PHASE I: Characterize the enabling methods and technologies (e.g. real-time middleware and operating systems) present in current real-time distributed systems that are required to support rapid fault detection and isolation. Develop detailed proposals for approaches that could provide similar performance capabilities within non real-time environments, ranking them according to effectiveness, invasiveness and practicality. These proposals should range in invasiveness from a minimum of merely providing a standalone service that can be used with minor modification of commercial system management products up to the installation of device drivers in the operating system and limited modification of the commercial system management product.

PHASE II: Develop a test bed using ubiquitous computing and communication technologies to test and evaluate the most promising of the proposed approaches. Attempt to integrate the best of the approaches with at least one commercial or open source system management product.

PHASE III: Demonstrate rapid, deterministic fault detection capabilities as integrated with an existing systems management product within the context of an existing prototype of a command and control or weapons system (e.g., HiPerD).

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is an increasing dependence on high-availability, distributed systems for many types of enterprise computing. Vendors of system management products can envision increased product interest and sales if those products can enhance system robustness via rapid, deterministic fault detection that enables timely recovery.

REFERENCES:

1. http://www.cs.cornell.edu/Info/Projects/HORUS/

2. A.Zitouni, C.Souani, M.Abid, K.Torki, R.Tourki, Communication Synthesis Approach for Distributed Systems, Techniques and Sciences Informatiques (TSI),Hermes Science Publication, April 2000.

3. S.Narayan and D.Gajski, Interfacing Incompatible Protocols Using Interface Process Generation, Proc.IEEE Design Automat.Conf., June 1995,pp. 468-473.

4. C. Wood and P. Clark. FADES: An Expert System for Fault Analysis and Diagnosis. TIRM 87-024, Turing Institute, 1987.

5. Lockheed Martin, Infrastructure Requirements For Aegis Open Architecture Baseline, Draft Version, June 2002.

KEYWORDS: Rapid Fault detection; real-time; distributed computing; faulty interfaces; inoperative nodes; distributed systems

N03-088 TITLE: Systematic Verification of Real-Time Interfaces Under Stress

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO for Theater Surface Combatants, Aegis Open Architecture (PMS 400-B)

OBJECTIVE: Develop, test and demonstrate the utility of a system design for identification of design patterns that apply to the construction of hard-real-time to soft-real-time interfaces

DESCRIPTION: Interfaces between components are critical to system function and performance. In a heterogeneous computing environment, connecting components such as a deterministic radar algorithm written in C++ with a soft-real-time GUI written in Java is key to future success. Future systems can be expected to be a mixed bag of technologies. The design and implementation of such interfaces and the supporting middleware is not easy. The systematic verification of the interface's function and performance under conditions that stress the limits of the design is an area of focus.

The identification of design patterns relevant to systems that preserve functional and behavioral attributes of the components while implementing the desired interface would reduce risk and focus the verification strategy. Over the lifetime of a system, components will be replaced many times. Each time, the function and performance of the interface must be verified. A verification methodology that facilitates the reduction of manpower and increases the level of assurance is desired. The role automatic test tools could play in verification of an interface between a hard-real-time component and a soft-real-time component based on an identified design pattern needs to be explored.

PHASE I: Develop a system design for the identification of design patterns that apply to the construction of hard-real-time to soft-real-time interfaces.

PHASE II: Develop and test the methodologies used to characterize interface performance.

PHASE III: Demonstrate the utility of tools that will facilitate the automated verification process.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A proven methodology to verify interfaces with reduced cost and greater assurance than ad hoc methods would add substantially to the value of the product and reduce maintenance costs.

REFERENCES:

1. Ronald Baker and John Grudia. Readings in Human-Computer Interaction. Morgan- Kaufman, 1995.

2. Charles Dubois. In Validation, Verification and Testing of Systems. M. Ayel and J.P. Laurent (Ed.), John Wiley & Sons, 1991.

3. Finton Bolton. Pure CORBA, A Code Intensive Preimum Reference. Sams, 2002.

4. Ravi Prakash, E. Subrahmanian and H.N. Mahabala. A methodology for systematic verification of OPS5-based AI applications. In Proceedings of International Joint Conference on AI, 1991.

5. J.P. Tsai and T.J. Weigert. Knowledge-based software development for real-time distributed systems. World Scientific Publishing, 1993.

KEYWORDS: Interfaces; systems; verification; real-time; components; test tools

N03-089 TITLE: Applying Fine Water Mist (FWM) Technology to DDG 51 Class Ships

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Theater Surface Combatants - DDG 51

OBJECTIVE: Develop prototype for low-cost implementation of water mist technology to replace existing Halon 1301 (CF3Br) halocarbon agent fire suppression systems on DDG 51 Class ships.

DESCRIPTION: Conduct research to determine optimum mist-delivery/generating technology (i.e. pump, accumulator, hybrid gas generator, or gas pump unit/ nozzle type) and system architecture that will afford the requisite fire protection for the current Halon protected spaces (machinery, turbine enclosure, flammable liquid stowage areas). The practicability for replacing existing light-hazard sprinkler systems may additionally be included within overall Water Mist fire protection strategy. Develop a cost/benefit analysis depicting affordability, space, and weight impact prior to delivery of final concept design

PHASE I: Determine the feasibility of developing an affordable implementation of water mist technology.

PHASE II: Develop prototype and demonstrate at land based facility

PHASE III: Develop full-scale system for installation on DDG 51 class ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The Montreal Protocol and its amendments have led to worldwide bans on the production of halogenated alkanes that can cause depletion of stratospheric ozone. These bans have created strong commercial interest in identifying alternative fire suppression agents that are toxicologically and environmentally acceptable, and that are as efficacious as halons in suppressing fire. Fine water mist technology provides a lightweight alternative to conventional sprinkler systems and provides safe, environmentally acceptable substitute for land-based halon and CO2 systems.

REFERENCES:

1. DOD Directive 6050.9 requires ".. R&D to identify or develop alternative processes, chemicals, or techniques for functions currently being meet with CFC's and Halons."

2. NFPA 750, "Standard on Water Mist Fire Suppression Systems," National Fire Protection Association, Quincy, MA, 1996.

3. Naval Studies Board, Committee on Assessment of Fire Suppression Substitutes and Alternatives to Halon, "Fire Suppression Substitutes and Alternatives to Halon for U.S. Navy Applications," National Research Council, International Standard Book Number 0-309-05782-5, Washington, DC, 1997.

4. Williams F.W.,et al, "Full Scale Machinery Space Water Mist Tests: LPD-17 Final Design Validation," NRL Ltr Rpt,Ser6180/0077,February,1997.

KEYWORDS: Fire suppression; Halon Alternative; Fire suppression; Fire tests

N03-091 TITLE: Improved Efficiency Broadband Amplifiers

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Improve the efficiency of mobile broadband RF amplifiers exploiting state-of-the-art semiconductor technology and amplifier design. Develop and demonstrate a 200-watt linear amplifier for the frequency range of 200 MHz to 3 GHz. Proposals can be based upon currently available amplifier designs emphasizing power efficiency, weight, and size to afford greater portability and minimize design risks.

DESCRIPTION: Greater emphasis placed upon mobility and interoperability of tactical and emergency response communications (both military and civilian) requires increasingly robust communications equipment. Mobile communications systems are limited by size, weight, portability, and power availability. In addition, communications antenna configuration is often a compromise between performance and portability. As a consequence of the above, optimization of wideband RF amplifiers is highly desirable. This effort will consider the optimum design of a wideband amplifier to improve efficiency thus reducing power consumption and providing greater portability within the limitations of the latest currently available technology. This effort should focus on various interrelated technologies to include high-power RF semiconductor research, advanced RF power amplifier configurations, improved heat transfer / cooling methodology, and advance DC power conversion techniques. Efficiency may be improved by limiting the number of amplifiers required to cover the 200 MHz to 3 GHz frequency range. This work will consider currently available technology and products found through market survey.

PHASE I: Identify and develop a wideband RF amplifier prototype design that includes one or more efficiency enhancement as described above. Clearly identify techniques and technologies that are mature enough for practical near-term application.

PHASE II: Develop and test, a prototype RF power amplifier fully demonstrating the enhancements identified in the Phase I design. Provide full documentation for the manufacture and procurement of an improve efficiency amplifier. Performance goals are as follows:

Frequency range: 200MHz to 3GHz
Output Power: 200 watts CW (+53 dBm)
Input power: 10 mw (+10 dBm)
Gain: +43 dB
Gain flatness: +/- 2 dB

PHASE III: Develop a proposal for the transfer of demonstrated amplifier improvements to the commercial manufacturing sector and for incorporation into commercial communications equipment designs.

REFERENCES:

1. R. C. Cumming, “Linearity and Intermodulation in High-Power Amplifiers”, IRE Transactions on Communications Systems, vol. 10, no. 2, June 1962 pp219-220

2. D, C. Cox, “Linear Amplification with Nonlinear Components: IEEE Transactions on Communications, vol. 22, no.12, December 1974 pp, 1942-1945

3. Donald C. Cox and Robert P. Leck, “Component Signal Separation and Recombination for Linear Amplification with Non-Linear Components”, IEEE Transactions on Communications, vol. 23, no. 11, November 1975 pp 1281-1287

4. D,C. Cox and R.P. Leck, “ A VHF Implementation of a LINC Amplifier:, IEEE Transactions on Communications, vol. 24, no. 9, September 1976 pp. 1018-1022

5. A.J. Rustako Jr. and Y.S. Yeh, “A Wide-Band Phase-Feedback Inverse-Sine Phase Modulator with Application Toward a LINC Amplifier”, IEEE Transactions on Communications, vol. 24, no. 10, October 1976 pp. 1139-1143

KEYWORDS: high-power, wideband, amplifier, communications

N03-096 TITLE: Short-Duration Manually-Driven Electrical Power Sources

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Design and build a low-cost manually-driven generator to power low-power electronic and electrical equipment for short duration under emergency operating conditions when conventional power sources become unavailable or unusable.

DESCRIPTION: Typically emergency communications occur under less than ideal conditions such as natural and man-made disasters. Limited power sources, quick response times, and uncertainties as to communications systems encountered (used by other responders and local commercial systems) emphasize the importance of developing and deploying efficient and robust short-duration power sources capable of interfacing with a variety of equipment. This development will provide users a short-term capability to deploy and continue to operate various equipment requiring power sources up to 100 watts. Approaches exploiting state-of-the-art materials and electronics will result in a lightweight rugged and durable electrical power generator.

PHASE I: Determine the feasibility of designing a manually-powered portable electrical generator capable of producing and storing 500 watt-minutes of electrical power. This power source will be capable of providing both AC and DC power compatible with commercial and military communications and rescue equipment.

PHASE II: Demonstrate and test a ruggedized field-deployable manually-driven prototype generator capable of providing 6, 9, & 12 volt DC and 115 volt AC power deliver at 100 watts total power (as a single or combined voltage output). These units will be designed to allow cascading for addition temporary power.

PHASE III: Provide full documentation for the manufacture and procurement of multiple power sources. Cost target is <$10,000 per unit.

COMMERCIAL POTENTIAL: This power source can be deployed during emergency conditions when normal power sources become unavailable. This power source reduces the requirement for transporting heavier engine-powered electrical generators, electrical storage devices, and fuel to remote areas during emergencies and for short-term power requirements such as for communications transmission. This design has commercial application to public emergency services.

KEYWORDS: manually-driven power, field power

N03-097 TITLE: Ultra-Wideband High-Efficiency Low-Profile Antennas

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Enable operators to use a variety of communications equipment with a single antenna for commercial and military applications up to 200 watts.

Develop and demonstrate antenna technologies that can operate (transmit and receive) over a wide range of civilian and military frequencies. This range includes 20 MHz to 4 GHz. Overall size and volume are important factors in design. One or more antennas integrated into a single antenna array / system is anticipated. Proposals can be based upon currently available designs but emphasize / prioritize wideband capability.

DESCRIPTION: Limited power sources, quick response times, and uncertainties as to communications systems encountered (used by other responders and local commercial systems) emphasize the importance of developing and deploying efficient and robust antenna systems capable of providing an interface to a variety of broadband communication equipment. Improvements to or optimization of current antenna systems would simplify and improve current operations.

PHASE I: Design and fabricate an antenna system exploiting emerging materials.

PHASE II: Demonstrate and test prototype antennas transmission and reception capability.

PHASE III: Develop a proposal for the transfer of technology to support new antenna production. Provide full documentation for the manufacture and procurement of low-drag mobile wideband antenna systems for use with a wide range of military, civilian, and foreign communications equipment.

COMMERCIAL POTENTIAL: This capability can be exploited to provide operation of various commercial communication equipment with a single multipurpose antenna eliminating multiple-installation difficulties.

KEYWORDS: antennas, communications

N03-098 TITLE: Development of New Program-Specific Geometry Models

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: This proposal is for an effort to assist in the construction of Real Time Champ (RTC) usable models to allow the Threat Signal Processor in the Loop (T-SPIL) facility to be prepared for future modeling efforts. Specifically it is proposed to construct an XXX model for use in RTC.

DESCRIPTION: Before any platform can be implemented into a new model, an accurate geometric representation of the model must be generated in a model-readable format. To ensure accuracy, geometry data must originate from a platform's manufacturer and then be used by a model. Acquisition of drawings, translation of data formats, and reduction of detail is a time consuming process that usually takes 6 months to a year. It is the intention of this study to reduce this time required by an order of magnitude.

PHASE I: Develop a tool to create a model-readable format of an accurate geometric representation of a platform. This must be compatible with RTC for utilization in the T-SPIL. This procedure is not to be understated, since compromises must be made in the level of detail of the geometry models to allow for reasonable computational times. Since too much detail slows model processing times to a crawl, while inaccurate or over-simplified data result in incorrect model predictions in hit-point, acquisition, and IRCM studies, it is important that modelers use geometry data that has been rigorously verified and accessible at a reasonable time. Additionally, it is proposed to assist in the construction of RTC usable formats to allow the T-SPIL facility to be prepared for future modeling efforts, and, specifically to construct an XXX model for use in RTC.

COMMERCIAL POTENTIAL: Application in several areas requiring modeling and development. Such applications may be significant in the commercial aircraft arena.

KEYWORDS: T-SPIL, model, geometry, IRCM studies

N03-099 TITLE: Acoustic noise reduction for large aircraft

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Develop noise suppression technology for reducing acoustic footprint of large transport and multi-function aircraft. Investigate feasibility of applying active acoustic noise reduction technologies to decrease aircraft external noise footprint and improve quality of life for residents near military airfields with high sortie rates.

DESCRIPTION: Increasing encroachment of civilian residential areas near and up to military airfield boundaries has led to an increase in noise complaints. The Federal Aviation Administration has also imposed more stringent noise abatement requirements for operations from civil airports. This has in turn led to restriction in flight operations as well as substantial changes in operating procedures and training methods. Small-scale active noise suppression systems have been used internally in military flight helmets to improve cockpit communications. Similarly, the technology has been investigated for larger scale applications such as reducing cabin noise of commercial airliners. This request is to investigate the feasibility of external application

PHASE I: Conduct research into the feasibility of a noise suppression system to reduce aircraft noise levels at source more than 20dB. Identify sources, spectral content, power and directionality of typical multi-engine military transport aircraft (Turbo fan and turbo prop) and their relationship to overall acoustic noise. Correlate sources with system requirements and investigate the use of existing commercial passive engine noise suppression systems in synergy with an active system to meet overall desired performance if not attainable with a single technique. Develop concept for implementation of an active noise reducing system. Investigate state of technology to meet constraints aircraft limitations would put on system components (size, power, installation volume).

PHASE II: Show benefits through simulation in typical installation. Develop laboratory model of device using representative or scale installation. If using scale model, identify issues for correlation to full scale. Conduct limited field demonstration of prototype. Develop cost information of device.

PHASE III: Conduct full-scale demonstration and prepare transition packages for specific platform incorporation.

COMMERCIAL POTENTIAL: Successful development of this capability would have broad application to commercial aviation. Nearly all takeoff and landing profiles and patterns are influenced by concern over noise abatement. The reduction of noise footprint would reduce noise complaints and improve most airport operations.

REFERENCES: Numerous “Aviation Week and Space Technology” articles on encroachment, noise, and noise reduction.

KEYWORDS: Acoustic, noise

N03-100 TITLE: Technologies to Support RO/RO Cargo Transfer in Sea State 5

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Littoral Combat and Power Projection FNC, Expeditionary Logistics

OBJECTIVE: To develop new materials and/or manufacturing techniques to provide high strength, light weight, high flexibility structures for transfer of Roll-On/Roll-Off (RO/RO) cargo between two freely floating vessels in the stream in sea states up to sea state 5.

DESCRIPTION: The current state of the art for RO/RO transfer in the stream is sea state 3, and many ramps are not certified for that. New concepts of Expeditionary Warfare dictate greater standoff distance from the beach to conduct in-stream operations. As the distance from the beach increases the probability of encountering sea states of 3 or less is reduced. The ability to operate in sea state 5 is required to have a sufficient operational window at the standoff distances. Ramps will be required to bridge between two independently floating bodies to allow vehicles to drive from the delivery vessel to the receiving vessel. The two vessels will have pitch, heave and roll characteristics that will likely be different from each other creating relative motions between the two ends of the ramp. The motions will also impart accelerations to the vehicle driving across the ramp. The ramp would have to be flexible enough in torsion to allow the relative motions between the ends of the ramp while also providing adequate strength and stiffness along the axis of the ramp. The receiving vessel will likely be much smaller than the delivery ship, and a heavy ramp would swamp the receiving vessel in a seaway. Ramps that are lightweight relative to their rated load and that are flexible are also useful pierside as they reduce weight impacts on the vessel. Similar technologies could be used for hoistable decks for car carriers.

For purposes of focusing proposals in this topic area, an existing ramp for this type of operation will be discussed. This does not imply that the specific ramp being discussed will be replaced by this technology, but it give an existing real world data point for the technology development effort. It is anticipated that the technology developed under this topic will be applicable to other future ramp applications. The Large Medium Speed Roll-on/Roll-off (LMSR) ships carry a sideport ramp for Ro/Ro operations. Information about the LMSR can be found at:

http://www.chinfo.navy.mil/navpalib/factfile/ships/ship-takr2.html
http://www.msc.navy.mil/inventory/inventory.asp?var=LMSRship
http://www.msc.navy.mil/inventory/inventory.asp?var=SurgeLMSRship

The ramp on the LMSR is 190 feet long with a clear driveway that is 24 feet wide. It has a truss structure along its two long sides to provide vertical plane bending stiffness. The ramp has a design load of 160,000 pounds and is rated for operations in up to sea state 3. It is essentially hinged at the LMSR end and sits on the deck of a Ro/Ro discharge facility (RRDF) at the other. The RRDF is a series of barge-like modules which are connected to each other and moored to the LMSR. The ramp applies significant vertical loads on the RRDF deck and point loads get very large at the ramp corners when the vessels have significantly different motions induced by the seaway. Proposals under this topic should focus on advanced materials and/or manufacturing techniques that enable a ramp of similar dimensions used in a similar fashion to carry the same load into sea state 5.

PHASE I: Conduct a preliminary material design and/or process analysis that would identify potential high strength, lightweight material and/or process improvements for a ramp that would allow vehicles to transfer between vessels in sea state 5. Relative motions and accelerations should be estimated in this phase. Proposals must be innovative, address R&D and involve technical risk.

PHASE II: Begin to develop new structures and processes for ramp structures that can transfer RO/RO cargo in sea state 5. Prototypes, scale if required, should be developed and tested. Interface Control Drawings should be developed. Producibility and affordability concerns should be addressed.

PHASE III: Technologies should be transitioned so that they can be incorporated into Navy and Commercial vessels.

COMMERCIAL POTENTIAL: Sea State accelerations contribute an overload condition on a ramp. Ability to meet sea state requirements will drive down the weight of the ramp relative to its rated load. Commercial shipping companies would likely be interested in lightweight, strong and flexible ramps if they were affordable. High speed ferries, which currently rely on shore based ramps due to the weight of a shipboard ramp, would be particularly interested in lightweight ramp technology as it can afford a greater range of operational flexibility while limiting the weight impacts on the ship.

KEYWORDS: Logistics; Cargo; ramp, RO/RO, sea state, structures

N03-101 TITLE: Enabling Hull Structural Innovations for High-Speed Lighters

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: Littoral Combat and Power Projection FNC, Expeditionary Logistics

OBJECTIVE: Develop hull structural materials and hull structural design concepts that enable the safe and reliable beaching, extraction, and in-stream cargo operations of high-speed lighters.

DESCRIPTION: Future Naval doctrine like Operational Maneuver From the Sea (OMFTS) and Ship to Objective Maneuver (STOM) require moving heavy equipment from a seabase over the horizon to a beach or austere harbor. Relatively high speeds in up to Sea State 5 will be required of these vessels.

To maximize cargo capacity and performance, the structure of these advanced lighters will need to be lightweight. The structure could be fabricated advanced materials to achieve the required strength to weight ratio. Traditionally, landing craft have been robustly built steel utility vessels. The lightweight structures found on high-speed vessels will not be suitable for the impact loads caused by beaching and interoperability with other vessels at sea which are both primary mission requirements for a lighter.

The proposed materials and / or structural design concepts must provide robustness in areas of likely impacts, integrate with the typical lightweight structures, and minimize the weight added to the high-speed lighter. The structures must withstand impact loads from beach, amphibious assault ship wet deck / batterboard, and other lighterage contacts when operating in Sea State 3. The goal is for these structures to withstand the loads caused by impacts in Sea State 5 without significant damage to the high-speed lighter. The proposed technologies should fortify the hull locally to withstand bottom contact loads (i.e., sand, gravel, and stones), lighterage contact loads (fenders and occasional shell to shell contact) and the overall structural loads induced by operating in a seaway, beaching, and mooring the vessel with other lighters and strategic sealift ships.

For this effort, the intent is to look at solutions that provide reduced weight and equivalent or superior impact resistance and strength to current steel structures. To focus this effort, we will use the LCU 1646 Class as an example. This does not imply that the technology will be applied to the LCU 1646 or a follow-on class. This is simply a lighterage vessel for which data on scantlings and size are readily available. It s expected that the technologies would be applicable to future lighters which have not been designed yet. Significant information for the LCU 1646 class can be found at http://www.globalsecurity.org/military/systems/ship/lcu.htm and numerous other web sites. The LCU 1646 Class lighters use 1” thick mild steel plate with the unstiffened panel size being 12” x 20” in the forward bottom of the hull for beach impacts. Technologies proposed under this topic should provide at least the strength and energy absorption of the existing steel panels while significantly reducing the weight. Material robustness must be maintained during operating environmental temperatures ranging from 0 degrees F to 130 degrees F. Cost of materials and manufacturing are also considerations. The proposed technology should result in fabrication costs no more than 100% greater than the fabrication cost of the steel structure it replaces. The lifecycle cost of the hull with the proposed technology should be lower than the lifecycle cost of the steel structure it replaces.

PHASE I: Develop an innovative material application concept and / or an innovative hull structural design concept that reduces weight and lifecycle cost while providing at least the same strength and impact resistance of steel at a very modest increase in fabrication cost. Use the LCU 1646 Class forward bottom scantlings as a design point for demonstration of the technology. An assessment of the flammability and gases emitted when burned should also be performed. Develop a test plan for proposed Phase II testing.

PHASE II: Develop the phase I concept and build full-scale prototype panels using the technology developed. Test the panels for strength, impact resistance, fatigue resistance, and weight. Develop a fabrication cost estimate based on the prototype fabrication cost and a forecast of production fabrication processes and efficiencies. Test the proposed technology for flammability and gases emitted when burned.

PHASE III: Develop and build a module using the developed technology for installation of a full-scale vessel for at-sea testing.

DUAL USE POTENTIAL: These technologies would be useful in regions with underdeveloped ports where high-speed transport and beaching (or other impact loading) are both desired. In addition, this technology would be applicable to any situation where high speed shuttles and at-sea interoperability are desired. Some examples are offshore supply vessels and cruise ship shore launches.

KEYWORDS: structures, loads, seakeeping, mooring, skin to skin, hydrodynamics

N03-102 TITLE: Compact Actuator System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Time Critical Strike (TCS) FNC

OBJECTIVE: Investigate various compact steering control concepts based on state of the art (SOTA) technologies that will meet the stressing weight, volume, performance and cost requirements for an advanced Anti Radiation Missile (ARM) system. The effort will lead to the development of a steering control system.

DESCRIPTION: The goal of this topic is to develop a low volume, low cost, low weight, high performance steering control system for the Navy's High Speed Anti-Radiation Demonstration program. The steering control system must be packaged in an annular volume with an internal diameter of 8.5 inches, outer diameter of 10.0 inches and 5 inches in length, actuator torque of 1200 in-lbs and slew rate of 500 degrees per second.

PHASE I: Using the HSAD Steering Control Section Specifications, develop innovative steering control concepts that meet the weight, volume and performance requirements of the HSAD vehicle. This will be accomplished by performing trade studies and analysis of the selected design concepts. Particular attention will be focused on affordability. Based on the results of the investigation, begin the development of a system through bench scale and other techniques to demonstrate and validate the concept. Proposals must be innovative, address R&D and involve technical risk.

PHASE II: Design, develop, fabricate and test a prototype steering control system. Perform analysis and testing used to validate the concept's ability to meet its requirements.

PHASE III: Make improvements/modifications to prototype design and scale-up manufacturing for test and evaluation phase in HSAD flight vehicle. This will validate the maturity of this concept through a flight test demonstration.

COMMERCIAL POTENTIAL: The compact steering control system would have application to future commercial systems that require high performance, cost effective mechanisms to precisely move hardware. Potential commercial systems include satellites (reduced weight requirements result in the need for compact mechanical systems), and the automotive industry (smaller, more energy/fuel efficient vehicles could require more compact mechanisms for the engine).

KEYWORDS: Actuators; Low Volume; Performance; Affordability

N03-103 TITLE: Active Cooling of High Heat Electronic Components

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: High Speed Anti-radiation Demonstration (HSAD) FNC

OBJECTIVE: The object of this topic is to develop viable, low-cost, low-volume active cooling solutions for electronic components used in missile systems.

DESCRIPTION: The US Navy is currently trying to improve the capability of deployed missile systems, such as the high-speed anti-radiation missile (HARM), by developing improved seekers, and motors that result in higher average speeds and the capability to travel longer distances. Current mission profiles and environmental conditions create high temperature issues that are only exasperated by the increased speeds and range. Current environmental design requirements state the initial soak temperature is 54 C (130 F). Seeker electronic components are active at takeoff and continue to produce heat. Electronic component heat thresholds are quickly exceeded resulting in failure of the components. Current cooling solutions look at passive solutions such as heat sinks, but these tend to be bulky and do not provide relief at higher speeds where the skin temperatures exceed the internal temperatures. There is a distinct need for new approaches to active cooling solutions to meet the low-cost, low-weight and low-volume requirements for the air vehicle.

PHASE I: Using the Advanced Anti-Radiation Guided Missile (AARGM) design concept evaluate innovative active cooling solutions that meet the weight and volume requirements of the air vehicle. Perform trade studies and analysis of the selected materials and concepts. Particular attention will be focused on affordability. Develop initial design concepts, and a program plan will be developed to evaluate the performance of the proposed solutions. Preliminary bench testing on the design concepts will be used to validate the proposed concepts. Proposals must be innovative, address R&D and involve technical risk.

PHASE II: Build the systems and perform analysis and testing using HARM electronic components. Provide report on performance improvements and cost implementation and maintenance impact.

PHASE III: Several actual missile firings will be performed to demonstrate the capabilities of the active cooling system.

COMMERCIAL POTENTIAL: The low-cost, low-volume active cooling systems evaluated on this program can be applied to electronics components in any situation in which there is unwanted heat in a highly constrained volume. Potential commercial uses include laptop computers (as processing speeds increase, and batteries improve, there could be a need for a low-cost cooling systems), and telecommunications (low-cost, low-volume cooling systems for remote relay sites).

REFERENCES:

1. Quinn, Robert D., Gong, Leslie, "A Method for Calculating Transient Surface Temperatures and Surface Heating Rates for High-Speed Aircraft" , NASA/TP-2000-209034, December 2000

2. Truitt, Robert Wesley, "Fundamentals of Aerodynamic Heating", The Ronald Press Company, New York

KEYWORDS: Electronics; High Speed; High Temperature; Active Cooling; Volume; Weight

N03-104 TITLE: <u>Low Drag Multi-Frequency Radome</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: High Speed Anti-radiation Demonstration (HSAD) FNC

OBJECTIVE: Develop, low-cost, seeker radomes that will meet the high speed and long time flight of tactical missiles and high speed aircraft.

DESCRIPTION: The US Navy is currently trying to improve the capability of deployed missile systems, such as the high-speed anti-radiation missile (HARM), by developing improved seekers and motors that result in higher average speeds and the capability to travel longer distances. The improved seekers utilize both radio frequency (RF) and millimeter wave (W-band) technology. Advanced dual-mode RF seekers utilizing these technologies require radomes that are compatible with both wavelengths and can survive the U.S. Navy's thermal-structural environment. Performance characteristics of dual-mode RF radomes require that materials be thin enough to pass the short wave length of the millimeter-wave energy and also be compatible with comparatively longer wave length RF energy without distortion or boresight errors. The radome must also act as a ground plane for the Anti-Radiation Homing (ARH) antenna and meet extremely rigorous loads and environments when subjected to very high-speed flight and captive carriage on U.S. Navy aircraft. This program will examine alternative materials, fabrication, coatings, and mounting techniques to develop and demonstrate affordable and reliable dual-mode RF radomes.

PHASE I: Using the HSAD design concept define and develop potential designs,study materials and construction methods for meeting missile radome performance requirements (see references). Perform studies and analysis of the selected materials and designs. Particular attention will be focused on affordability as it applies to materials, manufacturing concepts, and structural performance. One or more candidate designs will be proposed, and preliminary designs will be developed. Preliminary development and testing to determine performance requirements will be completed to validate the preliminary designs. Proposals must be innovative, address R&D and involve technical risk.

PHASE II: Develop one or more of the materials into a full radome prototype so that testing can be conducted. The most viable candidate from these tests will be engineered for production in Phase II or possibly an enhanced prototype.

PHASE III: Several actual missile firings will be performed to demonstrate the capabilities of the radome design.

COMMERCIAL POTENTIAL: Potential commercial uses include commercial radar systems, and high speed commercial aircraft (Boeing's high speed transport is one example).

REFERENCES:

1. B. J. Crowe, "Dual Band Radome Wall Design", Proceedings of the 18th Symposium on Electromagnetic Windows, pp. 61-66 (1984)

2. K. H. Breeden, "Electrical design Techniques for Millimeter Wavelength Radomes", Proceedings of USAF Avionics Laboratory/Gerogia Inst/ Tech. Symposium on Electromagnetic Windows, Vol II, pp. 41-90, June (1968)

3. Radome for Millimeter Wave Seekers KTA-10 Final Report", The Technical Cooperation Program, Oct 1986

KEYWORDS: Radome, High Speed, Dual Mode, Millimeter Wave, W-Band, Low Drag

N03-105 TITLE: <u>Technology for Shipbuilding Affordability</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: This topic is applicable to all Navy ship acquisition programs

OBJECTIVE: The objective of the project is to develop and implement innovative technologies that will reduce the cost to construct ships and thereby improve the competitiveness of the domestic shipbuilding industrial base and reduce the cost of military ships.

Description: US shipyards along with suppliers, owners, operators, and government personnel have developed the NSRP Advanced Shipbuilding Enterprise (ASE) Strategic Investment Plan (SIP). This plan contains an industry led strategy to promote commercial competitiveness and reduce the cost of military ships. It identifies Major Initiatives and Sub-Initiatives that are the R&D requirements for this industry. This entire plan was updated recently and is available for review on the World Wide Web at http://www.nsrp.org/. Coordinating with U.S. shipbuilders to adapt and implement "World Class" commercial best practices is encouraged. Of particular interest are initiatives directed toward implementing lean enterprise concepts. Proposals should indicate which areas are being addressed. Awards are planned to made to the highest rated proposals overall and not set aside within each research area. Proposals should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the estimated benefits will be and how it will be transitioned into the shipbuilding industry. Teaming with the shipbuilding industry to form integrated project execution and implementation team will improve transition potential and is strongly encouraged. Shipbuilding industry contacts are available at http://www.usashipbuilding.com under The Panels button.

Proposals under this topic must address at least one of the following 5 research areas related to the SIP:

1. PROCESS CONTROL
Develop, pilot, and provide to industry process control programs that address and/or employ standardized production processes, accuracy control techniques, and improved cost/schedule/quality management methodologies, based on a risk impact assessment. These efforts may include a focus on:

- Distortion control technology
- Electronic transfer of data
- Automated data analysis
- Quality improvement methods
- Statistical process control expansion
- Methods for mistake proofing processes
- Visual control methods

2. MANUFACTURING TECHNOLOGIES
Develop, pilot, and provide to the industry, manufacturing technologies (e.g., surface preparation and coatings, welding and joining, forming, etc.) process and/or material improvements that would result in measurable labor, cycle time and/or material savings. Focus areas to be considered include:

- Edge preparation technologies for removing sharp corners on profiles and plates
- Increased use of weldable preconstruction primers
- Alternative blast media and systems
- Portable/flexible containment systems
- Coating automation
- Joining technology
- Inspection methods and processes
- Material cutting, forming, and processing
- Cost-effective safety, health, and environmental improvements to these processes

3. OUTFITTING PROCESSES
Define, pilot and assimilate for the industry, an integrated steel/outfitting manufacturing model that demonstrates improved process control and improved off/on (vendor/onboard) ship integration testing. This process model would support the reduction of non-value-added activities and the move to a world-class manufacturing approach to construction. Focus areas to consider may include:

- Use of standard interim products
- Value Stream Mapping
- Cellular/flow manufacturing
- Improved process control techniques
- Process rationalization and automation
- Machinery package standardization
- Material handling

4. ADVANCED PRODUCT DESIGNS AND MATERIALS
The Advanced Product Designs and Materials sub-initiative includes the identification and development of new and "breakthrough" product designs and advanced materials required to ensure U.S. shipyards market differentiation in the ships of the future. Focus areas to consider may include:

- Shallow draft ocean going designs
- Automated cargo handling capability
- Advanced propulsion systems
- Standard integrated control systems
- Reduced shipboard manning capability
- Design for improved shipboard maintenance and safety

· Advanced adhesive products
· Innovated fire protection systems
· Unstiffened curved plate arrangements
· Protective coating
· Fast Ship technology
· Advanced composite structures
· Regulatory implementations associated with promising advanced product designs and materials

5. PARTS LIBRARY CATALOG SYSTEM (PROTOTYPE DEVELOPMENT AND FULL DEPLOYMENT)
The National Shipbuilding Research Program Advanced Shipbuilding Enterprise (NSRP ASE) has several projects underway that are defining and prototyping the infrastructure required for supplier catalog systems that interface with their shipyard infrastructure for large complex military ships. Shipyards which do not construct large complex military ships have less demanding needs for a supplier catalog system that interfaces with their shipyard infrastructure. Additional effort is needed to build on the NSRP ASE effort to define and prototype needs for those shipyards building less complex ships. The following is reflective of the U.S. shipbuilding environment that NSRP ASE is currently addressing: The information from supplier catalogs and shipbuilder parts libraries is basically parametric in nature. There needs to be a mechanism so that this parametric information can be transformed into the explicit form of the integrated product model. This capability would provide integration from the supplier's information to the integrated product model. For many suppliers, marine business is a small part of their overall business. Implementation of an electronic catalog for shipbuilding must provide a cost-effective solution for the marine vendor community at large, by taking advantage of standards efforts emerging from other industries. A prototype system should be developed before full deployment.

PHASE I: Prove feasibility for improvements being developed and detail where and why they will impact shipbuilding affordability. Include a Return-On-Investment (ROI) analysis for industry implementation and close collaboration with a shipyard customer to validate feasibility.

PHASE II: Develop a working prototype production system or prototype product to demonstrate its performance characteristics. Present the technology being developed to the NSRP ASE Major Initiative and technology panels, develop a commercialization (Phase III) plan, in coordination with NSRP ASE members, including descriptions of specific tests, evaluations and implementations (including sites and points of contact) to be performed.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the NSRP ASE Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed under this topic shall be applicable to both military and commercial shipbuilding practices and marketable to the shipbuilding industry.

REFERENCES: NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org/

KEYWORDS: shipbuilding; affordability; production; manufacturing; processes; maintainability

N03-106 TITLE: Efficient Reuse of Ontologies for Multi-Agent-Based Decision Support Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: MARCOR SYSCOM

OBJECTIVE: Design and build a software environment that facilitates a rapid migration path for existing multi-agent decision support systems so that they can be recast for new NAVY applications. In particular, this project focuses on developing semi-automated tools to enable creation of ontologies dynamically allowing naval engineers to quickly adapt legacy NAVY systems into new operational systems.

DESCRIPTION: Intelligent decision support systems often utilize multiple software agents for performing various tasks. In order to perform their reasoning tasks efficiently, the software agents depend heavily upon knowledge representation schemas specified through an ontology. Ontologies include the models of objects that pertain to a given system or problem, and the relationships connecting these objects. Agent reasoning and collaboration take place in the context of such an ontology. For each project involving a given problem for a multi-agent system, the bulk of effort lies in specifying the underlying ontology optimally. As ontologies become large, the human-oriented solution for recasting ontologies does not scale up. In practice, the design issues in an ontology often get influenced by the need to solve the problem at hand in an optimal fashion, instead of trying to formulate an ontology in generic terms with its reuse for other projects in mind. That is, the level of detail for an object definition, object type specification, an object's placement in the ontological hierarchy reflecting its relationships to other objects in the ontology, all get influenced by the overall problem-solving goals for the agent(s) that will use the ontology in a given context, instead of being generally applicable. Even though ontological engineers can often provide insight into the types of modifications needed to render the old framework reusable for the new problem, as ontologies grow, the human-oriented solution is not cost-effective. The cost of understanding the complexities in the current ontology, recasting the new problem in the old framework, and then deciding what changes should take place in the old ontology to effect a natural problem formulation, is often an expensive proposition. The frequency with which old ontologies need to be recast as well as the extent to which they need to be recast, warrants that a high level approach be taken towards semi-automating some of the ontology redesign tasks. Justification for building such an environment lies in the cost amortization of ontology design for multi-agent systems over several different projects. It is important to emphasize that the reuse of a legacy ontology to create a new one is governed by the closeness of the old and the prospective new ontologies. For instance, if the ontology to be reused is that related to a fruit orchard, and the ontology to be created is related to an airplane factory, it is clear that these two are much too distant to be considered. But if the legacy one is related to a helicopter factory, then it can be reused to create the more complex ontology related to an airplane factory. Tools and techniques are therefore needed for automating the process of ontology redesign for new projects. Smart software analysis infrastructures are required for analyzing existing systems that expose viable software regions that can be considered as alternatives for reuse.

PHASE I: Design and demonstrate a proof-of-concept system capable of exposing reusable regions in the context of a multi-agent support system. The system needs to enable analysis of an existing ontology and provide an infrastructure for discovering, capturing, and manipulating reusable software regions.

PHASE II: Develop a prototype tool that demonstrates applicability of concepts developed in Phase I for reusability in an operational naval setting. The prototype system should be capable of extracting fragments from an existing source ontology of a naval multi-agent decision support system and demonstrate the transition portions of the source ontology to a related target ontology with a different functional objective.

PHASE III: Integrate the tool into an ontology development environment for a commercial system which supports the building of ontologies.

COMMERCIAL POTENTIAL: Justification for building a tool that allows reuse of existing ontologies lies in the cost of amortizing the ontology design efforts over several different projects both in government and commercial sectors. In many applications the time necessary to create a new ontology can be critical. This type of a tool can offer a significant time reduction in the government and commercial ontology creation process, which translate into both cost reductions and earlier availability. Related application areas for this technology lie in all systems where ontologies get used heavily, such as, bioinformatics, telemetry systems, health and status monitoring systems, and intelligence operations.

REFERENCES: "Analysis Patterns: Reusable Object Models" by Martin Fowler. Publisher: Addison-Wesley. ISBN 0-201-89542-0.

KEYWORDS: Reuse, ontology, analysis, multi-agents, decision support systems, intelligent systems

N03-107 TITLE: Quantum Cascade Lasers

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACTIII AAR-47 Missile Warning Systems

OBJECTIVE: To develop a room-temperature mid-infrared communication source for secure point-to-point and ground-to-satellite communication. This technology will include the quantum cascade laser design and fabrication, as well as electronic modulation and collimating optics.

DESCRIPTION: A dependable and secure free-space communication link in a variety of atmospheric conditions is always desirable. Indeed, as opposed to microwaves, the information is carried in a small beam, making the information transfer more secure. Laser-based free-space communication systems at 1.5 mm are currently being utilized by many companies for information exchange where fiber is not practical.

A better suited laser-based system for free-space communication would operate in them id-infrared spectral region, within the 3-5 mm and 8-12 mm atmospheric windows. This is because mid-infrared lasers, compared to lasers at 1.5 mm and shorter wavelengths, benefit from lower divergence due to diffraction, lower scattering by smoke or other aerosols, and low atmospheric absorption in a wider band. These factors make a mid-infrared laser well suited for both short and long distance free-space communication.

The choice of sources in this wavelength range is limited at this time. CO2 lasers and parametric oscillators are quite bulky and require significant power to operate. Further, the optical cavity needs periodic adjustment to maintain performance. Semiconductor lasers, on the other hand, have an internal cavity, small size, and low operating power requirements.

In the past, mid-infrared semiconductor lasers had limitation due to cryogenic operating requirements, low output power, or both. With the invention of the quantum cascade laser, a new semiconductor laser source was uncovered that can operate at room temperature and is capable of significant average power. Further, the physical nature of the device is compatible with high-speed modulation. This program is devoted to developing the quantum cascade laser technology for system integration and analyzing the overall performance for practical application.

PHASE I: Determine feasibility by 1) Assessing the characteristics of currently available quantum cascade lasers (determination of the laser performance characteristics required for free-space communication applications); designing and fabrication of room-temperature, high average power quantum cascade lasers with emitting wavelengths in the 3-5 mm and 8-12 mm atmospheric windows; and designing methodologies to achieve the previously determined laser performance characteristics.

PHASE II: 1) Design and demonstrate a portable prototype laser pointer system, and design a laser driver for high-speed modulation and data transfer. The system should be low-weight, with battery power, and should include integrated optics for collimation. The quantum cascade laser should also be single mode.

PHASE III: Develop a communication system incorporating a single-wavelength or multi-spectral pointer subsystem with modulation circuitry and external interface. Operating characteristics, such as maximum transfer rate, sensitivity and lifetime will be determined.

COMMERCIAL POTENTIAL: Free-space communication with lasers, especially ground-to-satellite communication, offers many potential advantages over microwave transmission such as directionality. A similar system utilizing the quantum cascade laser would also be useful for systems designed for infrared countermeasure, LIDAR, and remote chemical sensing.

REFERENCES:

1. Razeghi, M. Kinetics of quantum states in quantum cascade lasers: Device design principles and fabrication, Microelectron J v 30 : n 10 , p 1019-1029 , 1999

2. Martini, R.; Gmachl, C.; Falciglia, J.; Curti, F.G.; Bethea, C.G.; Capasso, F.; Whittaker, E.A.; Paiella, R.; Tredicucci, A.; Hutchinson, A.L.; Sivco, D.L.; Cho, A.Y., High-speed modulation and free-space optical audio/video transmission using quantum cascade lasers, Electronics Letters, v 37, pg. 191, 2001

KEYWORDS: semiconductor lasers, quantum cascade lasers, mid-infrared, free-space communication

N03-108 TITLE: Compact Channelizing Filter Banks for Receiver Arrays

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Miniaturize wide band channelizing filter banks so that they can be deployed behind array based receive antennas without fan-out. Potential techniques include conventional filter materials and high temperature superconductors grown on high dielectric constant substrates, non-simple resonators, and optical mixing based filters.

DESCRIPTION: There is a critical and growing need for single rf receivers that can handle large (>10) numbers of simultaneous signals which occur at unpredictable times and have carrier frequencies that hop over multiple octaves of frequency. Rapidly adaptive components to meet this need are largely unavailable, must be actively controlled, frequently compromise performance, are expensive per copy, and usually service only 1 signal at a time. A channelized architecture depends the least on such components and has a clear potential to service many simultaneous signals. It combines immediate signal channelization and prompt digitization within the channel with digital filtering and beam forming. However, for this approach to work, the channelizing filters must be small enough to fit behind the antenna elements spaced so as not to produce grating lobes at the maximum frequency. This size requirement cannot be met by commercial filter banks today. Other desired properties are small total insertion loss, large dynamic range, low in-band intermodulation distortion, high out-of-band rejection, and wide (approaching octave) bandwidth in the individual channels.

PHASE I: Conceptualize the design of a complete filter bank spanning 3-5 octaves, having highest frequency of 2, 5, or 20 GHz and meeting the size requirement. Project circuit performance on the other parameters. Complete design of one of the required filters, fabricate it, and experimentally demonstrate that the projected full circuit performance specifications are realistic.

PHASE II: Confirm channel divisions are optimal for a specific DoN or joint services application. Complete design of all the filters, diplexers, etc. required for full filter bank, fabricate a prototype, and test. Report results.

PHASE III: Transition this new fabrication technology to a major rf systems integrator via corporate or FNC sponsorship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Wireless communications firms have a strong need to process large numbers of signals coming from random directions and at random times over a variety of frequencies and modulations. While their problems are less severe than the military's, software radio would definitely benefit from having large numbers of narrow spatial ("pencil") beams at a variety of frequencies at each base station.

REFERENCES: http://radar-www.nrl.navy.mil/areas/AMRFS/

KEYWORDS: electronically steered arrays; wide band technology; channelizing filter banks; miniature filters; digital beam forming; software radio.

N03-109 TITLE: Single Channel Ground Moving Target Indication (GMTI)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290 Maritime Surveillance Aircraft, PMA-265 F/S 18, PMA-263 Naval Unman

OBJECTIVE: This effort addresses techniques for the simultaneous detection, tracking, and geo-location of moving and stationary targets.

DESCRIPTION: Current single channel radars offer no capability for detection of ground moving targets. UAVs are often limited in aperture space and cannot supply the multiple phase center antennas which are required to provide this capability. This SBIR topic is soliciting single channel approaches to Ground Moving Target Indication with performance that is consistent with multiple aperture/phase center approaches.

Dominance in the military theater demands systems that can perform simultaneous multiple functions such as:
- Fast air target detection
- Slow ground moving target detection
- Ground and Air target tracking, and
- Accurate positioning of Ground Moving Targets within a synthetic aperture radar (SAR) scene.

Limitations in physical implementation of the shared apertures, prime power availability, and basic phenomenology associated with the multiple functions must be balanced against command situational awareness constraints and cost of implementation.

PHASE I - Analyze and model waveform and processing techniques for single channel GMTI solutions consistent with constraints of fielded Navy single channel radar systems and processors. Phase I would demonstrate through modeling the ability to simultaneously process and indicate the capabilities described above in a single channel radar.

PHASE II – Demonstrate the concept on real data in a non-real time environment, whereby reducing the risk to phase III.

PHASE III – Demonstrate the capability based on upgrades or modifications to a Navy radar in a actual test environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL:
This radar surveillance and tracking technology would also be applicable to many commercial applications.- Airport surveillance of ground traffic to help avoid collisions with aircraft that are landing and taking off- Phenomenology exploitation for civil engineering applications- Navigation and geodetic research in marine applications- Remote sensing

REFERENCES: Morris, Guy V., Airborne Pulse Doppler Radar, Georgia Tech Research Institute, Artech House, 1988.

KEYWORDS: Multi-mission Radar; Airborne Moving Target Indication (AMTI); Ground Moving Target Indication (GMTI); Synthetic Aperture Radar (SAR); Multifunction Waveforms; Simultaneous Transmit and Receive;

N03-110 TITLE: Sensor Independent EW Functionality Interface

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a sensor independent EW functionality interface that allows multiple EW sensors (RF/IR/EO) to use the same control and processing software.
- Provide sensor independent control and statusing algorithms/interface.
- Define and process sensor independent Universal Sensor Reports (USR).
- Correlate USRs prior to further processing.

DESCRIPTION: Current EW systems are designed around the sensor characteristics. Supporting sensor enhancements and adapting to different sensors requires significant rework of application software and control and processing. The proposed effort will define and develop EW control and processing software that does not rely on specific sensor characteristics.

PHASE I: Develop a proof of concept of how the sensor independent IRS will provide the information necessary to control the sensor, provide meaningful sensor status information to the operator, process and display emitters, deconflict emitter information from multiple sensors, and combine emitter information into platform information.

PHASE II: Develop a prototype system that interfaces with more than one sensor and uses the sensor independent IRS to - determine and display operator initiated sensor controls, display overall sensor status in a heads up display, display detailed sensor status on operator request, derive platforms and tactical information using sensor independent data, provide situational awareness displays, provide detailed displays of emitter parameters.

PHASE III: Add additional sensor interfaces and deconflict the emitter data. Determine when the same emitter is detected by more than one sensor, and combine the information into one emitter displayed to the operator. Correlate different emitters on the same platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Potential for use in any application interfacing with a passive sensor.

KEYWORDS: RF/EO/IR Sensors; EW Emitter Processing; real time computing systems; EW signal processing;

N03-111 TITLE: <u>Laser Beamrider Optical Countermeasures</u>

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop an effective optical countermeasure to laser beamrider missile systems.

DESCRIPTION: Most currently-deployed laser beamrider systems use optics for target acquisition and tracking. Government modeling and simulation has shown that temporary disruption of the operator's vision during these tasks is an effective countermeasure. This research will identify and develop innovative technologies to support optical countermeasures against laser beamrider missile systems. The countermeasure system may be either on-board or off-board. On-board systems will require advances in compact optical sources and/or beam handling and pointing. Off-board countermeasure devices will require advances in pyrotechnic materials and/or expendables packaging. Approaches which cause permanent damage to operator's eyes are not acceptable.

PHASE I: Investigate candidate technologies for generating optical energy and applying that energy to sensors. The sensors to be considered may include generic direct-view sights such as rifle sighting scopes and the eye, as well as optics representative of the target acquisition and tracking optics of a laser beamrider weapon system. Energy must be delivered in sufficient quantity to disrupt targeting functions by these sensors. Perform analysis to demonstrate that the required energy levels will not cause permanent eye damage. Produce a preliminary design for a prototype countermeasure.

PHASE II: Conduct a market survey to identify potential commercial uses of the technologies selected in Phase I. Conduct trade studies to optimize the Phase I design. Construct a prototype countermeasure system. Verify in the laboratory that the system does not produce energy levels that would cause eye damage. Measure/demonstrate system performance in field tests. Conduct radiometric measurements of the output of the prototype device to support analysis of effectiveness against laser beamriders and in the potential commercial applications identified earlier in this phase. If possible, include real threats or realistic simulators (supplied by the government) along with the other test instrumentation.

PHASE III: A unique opportunity to participate in a laser beamrider countermeasure system live-fire exercise is expected to be available during Phase III. Take part in this exercise to determine the effectiveness of the technology developed. Allow for participation by Phase III partners with interest in commercial applications. Use successful demonstration test data to define the requirements for future implementation of this technology. Formulate plan for the engineering development of the concept, including integration with existing and new naval platforms.

COMMERCIAL POTENTIAL: Technologies developed may have application in compact optical sources, beam conditioning/transfer, and/or efficient pyrotechnic materials. However, the potential for commercial applications will depend on the specific technologies pursued by the contractor. This will be reevaluated during Phase I as the preferred technological approach is identified. At the beginning of Phase II, a survey will be conducted to identify specific commercial applications for the technologies selected during Phase I. Two specific commercial applications have been identified. The first would be development of high-intensity signaling devices for use in search-and-rescue operations. This appears a likely commercial application based on the fact that one U.S. pyrotechnics company currently sells pyrotechnic devices in at least two markets. Technology developed under this topic could provide a brighter device for this same application, capable of signaling rescuers at extended distances. The second possible commercial application would be useful in crowd control and in terrorist situations. This could provide a more effective (brighter) version of the non-lethal "flash-bang" grenades used by police and other security forces.

REFERENCES: Naval Research Laboratory Broad Agency Announcement BAA-01-01-114.

KEYWORDS: Laser beamriders; Countermeasures; Optical countermeasures; Optical sources; Eye-Safe

N03-112 TITLE: Modeling and Simulation of Cultural Differences in Human Decision-Making

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop models and algorithms to simulate cultural characteristics in human decision-making that can be used 1) to account for the cultural differences in coalition or multinational collaborations leading to improved decision-making and planning; and 2) to understand the behavior of enemy forces for better predictions of an adversary's actions and detection of asymmetric threats.

DESCRIPTION: Military operations today are inherently multinational in scope, requiring quick decisions in complex situations and knowledge based on uncertain information. Humans typically predict the actions and reactions of others based on their own culture, ethics and background. For example, the motivation and concern of one commander might be on taking actions that preserve lives and minimize the destruction of civilian infrastructure. On the other hand, an enemy decision maker might not care about the loss of his own forces or the destruction of civilian residences. If the commander bases his decision on a prediction of enemy behavior, which is based on his own motivations, then he might make poor decisions. An important shortcoming of models for planning and decision-making is to account for differing world views based on cultural differences in cognition. The SBIR project described here seeks to explore new algorithms, models and computational methods to simulate how cultural differences affect human decision-making, especially under complex, time-constrained situations or conditions of excessive uncertainty.

PHASE I: Describe and develop the algorithms, techniques and system design to model and simulate a culturally based decision-making process, especially in stressful and uncertain situations.

PHASE II: Develop, implement, and validate a system that extends the understanding of how humans make decisions in situations requiring multinational collaborations and in military situations. This should include the ability to visualize complex interactions of critical components leading to rapid human understanding of the decision-making situation.

PHASE III: Implement the models and algorithms in a comprehensive package that would include an intuitive graphical user interface (GUI). Transition possibilities include the Testing Experimentation Assessment Modeling and Simulation facility at NSWC, Dahlgren Division and the Army CTA on Advanced Decision Architectures.

PRIVATE SECTOR COMMERCIAL POTENTIAL: With the move toward multinational corporations and research teams, there is an increasing need for understanding cultural barriers and collaborative decision-making. Thus, these models can be used in any environment involving multinational teaming, planning, training and decision-making.

REFERENCES:

1. Decision-making in Action: Models and Methods, Klein, Orasanu, Calderwood and Zsambok (eds.), 1993, Ablex Publishing Corp.

2. Decision-making under Stress, Flin, Salas, Strub and Martin, 1997, Ashgate Publishing.

3. "Cultural barriers to multinational C2 decsion-making," Klein, Pongonis, and Klein, 2000, Proceedings Command and control Research and Technology Symposium.

KEYWORDS: Decision-making; cultural models; modeling and simulation; uncertainty; asymmetric threats; collaboration

N03-113 TITLE: Zinc Oxide Based Photonics Devices

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACTIII AAR-47 Missile Warning Systems

OBJECTIVE: To develop zinc oxide technology for commercial UV - visible light emitting diode (LED) and laser diode (LD) applications. Other major application areas include sensors and high frequency communication devices. This technology will include diode laser design and fabrication.

DESCRIPTION: High brightness, long lifetime light emitting diodes and lasers for the blue/visible and blue/UV regions of the spectrum are desirable for use as light sources and as sensors. Semiconductor light sources and lasers are desirable because they are light weight and can use battery sources, increasing portability. The choice of semiconductor sources in the blue wavelength range is limited to gallium nitride heterostructural devices as a light emitting diode. No commercially available laser diode sources have been developed. Zinc oxide is a wide bandgap material (3.3 eV) with structural and electrical characteristics similar to those of gallium nitride. Interest in use of zinc oxide for devices is increasing rapidly due to breakthroughs in p-type doping. Zinc oxide has been grown with p-type carrier concentrations in the range of 1015 to 1018 per cm3. Compared with gallium nitride, results for zinc oxide show higher doping levels, markedly higher activation of dopant atoms, better electron and hole mobilities, and decreased defect densities. Possibilities exist for fabrication of zinc oxide homoepitaxial devices that may show greater thermal stability, higher powers and longer lifetimes than would heterostructural designs. This program is devoted to developing zinc oxide technology for system integration and analyzing the overall performance for practical applications. . A laser with average power of 10 mW or greater would be desirable.

PHASE I: 1) Assess the current state-of-the-art in zinc oxide p-type doping, p-n junction fabrication and light emission; e.g., determine the light emitting diode, laser diode and sensor performance characteristics required for display and communication devices based on zinc oxide material; 2) Design and fabricate room-temperature, high average power light emitting diodes and laser diodes, and light detecting optical sensors, based on zinc oxide material operating in the UV to visible spectral region; and 3) Develop methodologies to achieve the previously determined light emitting diode, laser diode, and sensor characteristics.

PHASE II: 1) Demonstration of a prototype light emitting diode, diode laser, and sensor (each should be low-weight, with battery power); 2) Design and fabrication of room-temperature light emitting diodes and laser diodes, and light detecting sensors, based on zinc oxide material operating in the UV to visible spectral region; and 3) Design and fabrication of field-effect transistor and high frequency transducer based on zinc oxide material.

PHASE III: Production of light emitting diodes and laser diodes operating in the UV - visible based on zinc oxide material. Production of sensors for the UV - visible spectral region, and development of high frequency transducer, based on zinc oxide material.

COMMERCIAL POTENTIAL: The availability of high brightness, low weight, battery powered blue light emitting diodes, laser diodes, optical sensors for the UV-visible spectrum, high frequency transducers, and field-effect transistors with stable, long-lifetime operating characteristics offers advantages over current technologies for electronic displays, communications, and detection capabilities.

REFERENCES:

1. “Zinc oxide films containing p-type dopant and process for preparing,” H. W. White, S. Zhu, and Y. R. Ryu, US Patent Number 6,291,085 (2001).

2. “Oxide films and process for preparing same,” H. W. White, S. Zhu, and Y. R. Ryu, US Patent Number 6,342,313 (2002).

3. "Optical and Structural Properties of ZnO Films Deposited on GaAs by Pulsed Laser Deposition," Y.R. Ryu, S. Zhu, J.D. Budai, H.R. Chandrasekhar, P.F. Miceli, and H.W. White, J. Appl. Phys., 88, 201-4 (2000).

4. “Synthesis of P-Type ZnO Films,” Y.R. Ryu, S. Zhu, D.C. Look, J.M. Wrobel, H.M. Jeong, and H.W. White, J. Cryst. Growth 216, 330-34 (2000).

KEYWORDS: semiconductor lasers, light emitting diodes, optical sensors, UV-visible, high frequency transducers.

N03-114 TITLE: Tools for Simulating Terrain Data

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM:

OBJECTIVE: Develop computer-based tools, algorithms, and models to simulate terrain data that can be used to 1) study the impact of terrain data fidelity on military system performance, and 2) produce terrain data that accurately models specified geographic attributes (elevation, shape, features, etc.). The final product must be able to work with emerging terrain data interchange standards (e.g., Synthetic Environment Data Representation Interchange Standard-SEDRIS, USGS Spatial Data Transfer Standard, NIST Integrated Standards for GIS, etc.).

DESCRIPTION: Although terrain data gathering sensors and methods have increased in capability, acquiring accurate terrain data is still costly, impractical, and in some cases impossible because of political restrictions. Here we include elevation data and feature information under the general heading of terrain data. The ability to produce synthetic terrain data with predetermined topographic attributes, grid resolution, and fidelity would support the development of Geographical Information Systems (GIS), tactical decision aids, terrain sensors, and training systems, as well as provide non-classified representative terrain data sets. The need to exchange terrain data in a common format has been addressed by DoD and industry (http://www.sedris.org), but the development of a standard method of generating synthetic terrain data that is statistically similar in elevation, artifact, and feature content to any given existing terrain has not been pursued. This effort seeks to explore new and creative technologies, algorithms, and models to simulate terrain data for use in the analysis, development, and benchmarking of systems that use this type of geographic information. The technology should include the ability to accurately model and simulate the terrain data at a given level of fidelity. Some sources of terrain fidelity that might be considered are 1) resolution of elevation data, 2) sensor measurement error, 3) accuracy and completeness of terrain features, and 4) compression techniques or other processing of sensor data.

PHASE I: Describe and develop a computer-based framework for incorporating, developing, and exercising terrain data models that can be used to synthesize terrain data with representative errors and statistics associated with terrain measuring sensors and methods.

PHASE II: Demonstrate the framework developed in Phase I by implementing a terrain data generating system that would produce terrain data that realistically represents a specified geographical area.

PHASE III: Implement a comprehensive software system whereby a user can specify (through a graphical user interface) the data gathering sensor/method, the desired terrain attributes and produce a synthetic terrain data set.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The ability to accurately simulate terrain data can be used in conjunction with Geographical Information Systems (GIS) software or any system that relies on the interpretation of terrain data for analysis or decision-making. The simulation of terrain data can be used in the modeling and analysis of spatial patterns of many types of environmental phenomena. This tool would be welcomed as an inexpensive alternative to purchasing real terrain data by any business that depends on remote sensing, mapping and GIS.

REFERENCES:
1. Terrain Analysis: Principles and Applications, John P. Wilson, Ed., John Wiley & Sons,(2000), ISBN: 0-471-32188-5.

2. Linear Algebra, Geodesy, and GPS, Gilbert Strang and Kai Borre, Wellesley-Cambridge Press, (1997), ISBN: 0-9614088-2-0.

KEYWORDS: Modeling and simulation; terrain elevation data; topographic attributes; terrain analysis; grid resolution; terrain feature data

N03-115 TITLE: Multifunction, High Resolution, High Frame Rate Infrared Sensor

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS - 473

OBJECTIVE: To develop a flexible high performance infrared (IR) imaging camera system for use in a variety of high-speed passive and active tracking and ranging applications.

DESCRIPTION: There are a wide range of high performance IR camera systems currently available that satisfy a number of testing applications, however, these systems do not provide adequate frame rate and speed performance to meet current active and passive tracking and ranging testing needs. To fill these needs, the development of a flexible, high performance, low latency, high-speed, mid-wavelength and long-wavelength IR focal plane array (FPA) based camera system is desired. It is expected that the desired feature set for the high-speed array would require the development of a high-speed IR FPA, however, it is desirable that the development leverage an existing camera electronics and system in order to lower development cost. The IR FPA sensor will be required to be 640 x 512 (or 512 x 512) pixels with 25um pitch and to support a feature set specific to high-speed imaging applications including high-speed windowing, pixel dilution, and multiple high-speed outputs. In the windowing operation the FPA will support a frame rate of >50,000 Hz for a 32 x 32 window. The integration times must be fully user-adjustable as to start and duration relative to the frame sync. The full-frame mode must operate up to >200 frames per second. Automatic gain control with AGC-disable is required in the camera. The non-uniformity correction is required to maintain the specified performance for 5 hours. The field-of-view of the sensor will need to be ~2 degrees and the transmittance of sensor optics >70%. Closed cycle cooling is desirable.

PHASE I: Perform a trade study for the optimum feature set for the multifunction high-speed sensor and define the FPA and camera operational requirements for the active and passive tracking and ranging testing applications. Perform preliminary analog and digital circuit designs for the 640 x 512 pixel high-speed IR FPA.

PHASE II: Based on the results of phase I, complete the high-speed IR-FPA design and fabricate a prototype high-speed IR FPA based camera. The camera system shall perform a variety of real-time digital imaging and data storage operations on the high-speed data that is produced in a laboratory demonstration at the end of Phase II.

PHASE III: A fully functional high-speed IR FPA based camera to be used in contractor-assisted field testing applications will be delivered. The camera will be ruggedized and cryo-cooled for field tests in military and commercial applications.

COMMERCIAL POTENTIAL: Potential private sector applications include 2 color temperature monitoring, non-destructive testing, infrared spectroscopy, infrared surveillance, laser ranging, and high-speed chemical reaction analysis and infrared photography.

REFERENCES: "High Speed Gated Imaging For Laser Applications Research Using The PhoenixTM Camera System", SPIE, Thermosense XXIII, Mark Nussmeier

KEYWORDS: focal plane array; infrared; sensor; camera; dual band; imaging

N03-116 TITLE: Four dimensional (4-D) Atmospheric Instrumentation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

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

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain meteorological (METOC) variables (e.g., physical, chemical, optical, geophysical) 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), ships, buoys or with expendable instruments), (3) providing a significant reduction in instrument weight, volume and power 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: instruments to measure aerosol properties, optical properties, the next generation of low cost METOC expendable instrumentation, or the accurate measurement of temperature, humidity, winds, and wave properties near the surface in extreme conditions. 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 in sensitivity or reliability and cost savings for existing expendable instrumentation, or would develop new expendable capabilities for measurements currently obtainable by other means (such as aerosol properties, scattering absorption and phase function, visibility, IR extinction, etc.). All platform deployment scenarios are included and expendables can be launched, dropped, drift, etc. Priority is given to devices that can lead to substantial improvements in 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 and quantify its ability to acquire field measurements of appropriate quality and reliability from an atmospheric or oceanographic 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.

REFERENCES: Rapid Environmental Assessment, SACLANTCEN Conference Proceedings Series CP-44, E. Pouliquen, A.D. Kirwan, Jr., and R.T. Pearson, eds., NATO SACLANT Undersea Research Center, La Spezia, Italy, 1997.

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

N03-117 TITLE: Tactical Anti-Submarine Warfare (ASW) Environmental Sensing

TECHNOLOGY AREAS: Sensors, Battlespace

OBJECTIVE: Develop advanced environmental sensor technology to support improved real-time ASW sensor performance estimates, adaptation of ASW sensor operation to the environment and extraction of data from ASW sensors to support modeling and simulation (M&S) of future sensor performance. This objective will support the LASW FNC projects called Advanced Estimation of Sensor Performance and Multistatic Active Systems.

DESCRIPTION: The focus of this SBIR topic is to stimulate innovative concepts for environmental sensing technology to include: Remote and in-situ sensors that provide real-time on-board measurements of current environmental conditions that affect performance of ASW sensors. Inversion techniques that support in-situ collection of environmental data from ASW sensors. These sensing technologies will be used for improving sensor system detection, classification and localization (DCL) performance; system performance estimations and development of future systems through modeling and simulation. The proposed environmental sensor technologies should apply to various ASW surveillance and tactical platforms including weapons. Active acoustic sensors work in the frequency range of 100 Hz to 30 kHz. Non-acoustic sensors of particular interest are electro-optic and magnetic. Basic environmental parameters such as SSP, temperature, bottom loss and backscatter should be measured and the data support development of real-time environmental parameters for acoustic systems. Non-acoustic data should include, but not limited to, optical back-scattering and absorption in the upper water column (approximately 300m.). Sensor technologies should consider the impact of environmental variability and their ability to identify environmental state uncertainty. These technologies are in direct support of the Office of Naval Research's Littoral ASW Future Naval Capability, Enabling Capability "Characterizing the Battlespace."

PHASE I: Develop and document sensor concepts describing the theory of operation and predicted performance of the sensors in representative operational environments. Document the value of the environmental sensor concepts to ASW sensor performance, sensor performance prediction, and M&S.

PHASE II: Fabricate and test a breadboard (experimental) prototype of the sensors and associated signal processing. Provide clear and complete documentation of the prototype's final design, functionality, and testing that has been conducted to demonstrate performance.

PHASE III: Design, fabricate and test advanced developmental prototype sensors and processing.

COMMERCIAL POTENTIAL: There is a commercial market in for advanced sensor technology. The technology developed in this SBIR could be of use in a wide range of applications outside the military.

REFERENCES:

1. Gauss, Roger, "The Role of the Environment in Active Sonar Performance," NRL Washington, D.C., Navy Journal of Underwater Acoustics, January 1997

2. Sienkiewicz, Charles G., Michael L. Boyd and Robert T. Miyamoto, "Shallow water environmental effects on torpedoes (U)" (Confidential). U.S. Navy Journal of Underwater Acoustics (U), Special Feature: Shallow Water Acoustics, 42(4), 1992 (SECRET).

KEYWORDS: Environment, Sensor Performance Estimation, Modeling and Simulation of Sensor Performance

N03-118 TITLE: <u>Scene Model For Low Observable Infrared Surface Combatants</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO (STRIKE), PEO (TSC), PMS-500, PMS-400, AAAV, PEO (Carriers)

OBJECTIVE: Enable analysts and designers to predict the low-observable (LO) infrared performance of future ship combatants.

DESCRIPTION: Current infrared scene models have enough fidelity to model non-LO infrared surface combatants in an ocean environment: however, they do not provide adequate fidelity to predict the infrared signatures of LO surface combatants. Improved physics needs to be included in scene rendering to provide the necessary fidelity for prediction of LO infrared signatures of surface combatants.

PHASE I: Identify and develop the physics formulations and methodologies that are necessary to provide the fidelity for infrared scene modeling of LO surface combatants. Detail the software architecture necessary to implement the code in a manner compatible with industrial code standards. Identify any scene rendering algorithms that currently provide adequate fidelity for LO infrared rendering and any modifications that might be necessary for integrating them into the chosen software architecture.

PHASE II: The methodologies that are identified in Phase I to provide the necessary fidelity for an LO infrared scene model would be implemented in computer algorithms in an approved software architecture. The resulting computer code would be validated against government supplied test cases.

PHASE III: The computer code would be transitioned to government facilities that would be evaluating LO surface combatant ship designs and to prime contractors (e.g., shipbuilders) that are responsible for the design of LO infrared surface combatants.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The advanced thermal codes that are part of the rendering scene models have applications to automobiles where engine systems response to thermal phenomena, including internal heat sources and sophisticated real-world environmental conditions. In addition, the algorithms that are developed would be applicable to improved visual renderings for commercial endeavors.

REFERENCES:

1. J. Thompson, D. Vaitekunas, B. Brooking, “Lowering Warship Signatures: Electromagnetic and Infrared,” Proceedings of the Signature Management - The Pursuit of Stealth Conference, 21 and 22 February 2000.

2. Art Reed, Editor, Report of the ONR IR Working Group, 30 April 2002.

3. Don Forester, Editor, Infrared Code Workshop, 23-25 February 1994, Hosted by the Naval Research Laboratory, Signature Technology Office, Code 5050.

4. W. Roland Davis, “Application of Modern Simulation Technology for Analysis of Platform IR Design,” Proceedings of the SMi Conference entitled Signature Management: The Pursuit of Stealth Conference held 11-13 March 2002, The Hatton, London

KEYWORDS: Infrared signatures; scene modeling; visual rendering; low observable.

N03-119 TITLE: Hybrid electric drive for small craft

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS-400 Aegist Wpn Sys

OBJECTIVE: The objective is to demonstrate potential fuel efficiency improvements and signature reductions available by converting Naval small craft from diesel mechanical drive to hybrid electric drive.

DESCRIPTION: Current Naval small craft design and construction is limited by the direct diesel mechanical drive system. By pursuing the development of novel hybrid electric drive systems, the potential exists to produce design and construction flexibility, fuel efficiency improvements, and signature reductions on Naval small craft. The craft of primary interest for this topic is the Navy's standard 7-meter rigid hull inflatable boat (RHIB) , which are carried on board most Navy surface vessels, and are often used in port operations and other applications. The government will provide necessary technical details on the existing RHIB design. The primary goal of the conversion shall be to maintain existing top speed performance and payload while reducing fuel consumption at all speeds, thereby enhancing range. Other goals include making more power available to non-propulsion mission loads and providing a "stealthy" battery-only mode of operation. It is anticipated that innovative technical approaches will be needed to meet performance goals within the constrained weight and volume of the RHIB. The Navy is also developing a family of unmanned surface vessels based on the 7-meter RHIB platform.

PHASE I: In phase I the contractor shall develop a conceptual design for conversion of an existing Navy small craft to hybrid electric drive. The conceptual design shall include system line diagrams and location drawings showing equipment removal and installation to perform the conversion, and shall include estimated weights and volumes for components.

PHASE II: In phase II, the contractor shall modify a government-provided RHIB to hybrid electric drive and shall test the craft in water to verify performance predictions and show reliable operation. The modified craft, test results, and technical data on the conversion shall be delivered to the government.

PHASE III: Plan replacements of RHIBs in future procurements. Any contractor with demonstrated performance in Phase II would be in a good position to compete for these procurements, either individually or in a teaming arrangement with a boat builder.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial market for work boats and pleasure boats in the size range of the Navy 7-meter RHIB is very large. Commercial and pleasure boat owners would be strongly attracted to hybrid diesel-electric propulsion due to significant fuel savings and potential for quiet operation of auxiliary equipment while pierside.

REFERENCES: www.zodiac.com – manufacturer of current Navy 7-meter RHIB.

KEYWORDS: Boat; electric; propulsion; hybrid; diesel; craft

N03-120 TITLE: New Low Cost Resins Systems

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: DD(X) program (PMS-500) and Virginia class submarine program (PMS-450).

OBJECTIVE: To develop a new resin system with reduced Flammability, Smoke, and Toxicity (FST) properties when compared to the Navy's present halogenated vinyl ester (Derakane 510A) resin but with mechanical performance and processing properties comparable or better than VARTM-processed Glass/Vinyl Ester system. One must therefore compensate for the loss of the flame suppressing properties of the halogenated resin by either the development of a new resin, choice of a novel resin or coupling of resin and novel flame retardants. The constraint is that the approach must be compatible with the Navy preferred VARTM processing.

DESCRIPTION: Composite materials offer a large number of advantages over conventional metals when applied to the naval environment. Composite materials can have the strength of steel at a fraction of its weight and will not corrode. The fatigue performance of composite materials is exceptional. While the material costs are higher than those of structural steel, the long-term behavior combined with the low maintenance requirements can afford better total ownership cost (TOC) characteristics. Furthermore, these materials lend themselves to multi-functionality due to high degree of flexibility during fabrication, i.e., besides their structural role a different function can be imparted (e.g. RAM, EM windows, etc.) to them.

There is a long way to go to meet Navy FST goals. A first step is to attain the FST performance of the current halogenated vinylester-based composites with a nonhalogenated resin while maintaining VARTM processability. However, the large concentrations of traditional flame retardants needed to meet flammability specifications often reduce laminate mechanical properties and/or increase resin viscosity beyond the limit for facile processing. Novel approaches are needed. The Navy standard low flammability vinyl ester resin is Derakane 510A. Laminates are made with coarse woven glass to roughly 50 volume percent. Flexural strength and modulus are about 55 ksi and 3.0 msi, respectively. Cone calorimetry tests typically have times to ignition of 80 seconds and maximum heat release rates of 110 kW/m2 at an incident heat flux of 50 kW/m2.

PHASE I: During Phase I of the program the PI will demonstrate that: 1) The candidate resin system has mechanical properties that are comparable or better than those of vinyl esters; 2) The FST behavior of the candidate resin system is comparable or better than the standard halogenated vinyl ester resin system as evidenced by fire tests such as heat release rates and smoke generation (ASTM 1354); 3) That the processability of the new resin system is comparable to that of vinyl ester systems in terms of room temperature or low temperature curing capability and low viscosity amenable to VARTM processing; 4) That the proposed resin system is compatible with glass reinforcement for structural applications. The PI will determine the resin manufacturing cost as a function of the material quantity.

PHASE II: Optimization of approach and then production of larger panels for FST performance testing such as ISO 9705 room corner fire tests, and UL-1709 fire resistance tests. A demonstration prototype such as the section of a composite mast, or a helicopter hangar, or a deckhouse will be fabricated. Cost estimates will be determined.

PHASE III: Large scale manufacturing of the resin will be optimized and documented. In coordination with a NAVSEA program office and with engineers at NSWC, the PI will manufacture components for complete characterization at the Naval Surface Warfare Center and, if successful, build a prototype for at sea trials including shock.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Fiberglass is used in the home (vanities, countertops, ladders), in vehicles, in boats, airplane interior compartments, and many other places where reduced flammability is an issue.

REFERENCES:

1. MIL-STD-2031 (SH), “Fire and Toxicity Test Methods and Qualification Procedure for Composite Material Systems Used in Hull, Machinery, and Structural Applications Inside Naval Submarines” (Feb 1991).

2. U. Sorathia, G. Long, M. Blum, J. Ness, T. Gracik; “Performance Requirements for Fire Safety of Materials in U.S. Navy Ships and Submarines”, Proceedings of 46th International SAMPE Symposium and Exhibition, Volume 46, Book 2, May 2001.

3. Sorathia, U. and C.P. Beck, “Fire-Screening Results of Polymers and Composites,” Proceedings of Improved Fire and Smoke Resistant Materials for Commercial Aircraft Interiors, National Research Council, Publication NMAB-477-2, National Academy Press, Washington, DC (1995).

KEYWORDS: Fire, Smoke Toxicity, High Temperature Resins, Composites, VARTM

N03-121 TITLE: Sensors for condition monitoring of hydraulic fluids

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes, Sensors

Objective: To develop in-situ sensors for monitoring functional properties of hydraulic fluids in air vehicles and ground support equipment.

Description: Degradation and/or breakdown of hydraulic fluids on aircraft systems is a common occurrence, and which requires periodic determination of its condition through laboratory analytical procedures. Replacing the fluid too early results in unnecessary waste management, costs and downtime; replacing the fluid too late can damage the system in which it is used and can be mission critical. The laboratory tests performed to check the condition of the fluid are time consuming and costly, and cannot be performed routinely on all systems. A sensor or suite of sensors which can be installed or implemented in a dipstick or similar fashion to monitor the status of the hydraulic fluid and indicate when the fluid needs to be changed would reduce unnecessary downtime, and costs (including disposal) while improving reliability and mission success.

PHASE I: Develop a concept for a sensor or suite of sensors which are capable of monitoring several parameters (functional properties) that would indicate the extent and different forms of degradation of hydraulic fluid;

demonstrate said sensor(s) in the laboratory; and develop initial protocols for measurement and analysis of key properties.

PHASE II: To perform further development and testing of sensors. Incorporate onto a dipstick or some other suitable component. Correlate sensor measurements with specific forms and extent of fluid degradation. Determine acceptable sensor readings. Demonstrate and validate the technology on Navy equipment or facilities. Develop plans for scale-up and transition to fleet.

PHASE III: Additional military applications would be examined and might include Navy ships, Air Force and Army aircraft & rotorcraft, support equipment, and ground support facilities.

Private Sector Commercial Potential: This technology also represents a high payoff potential for the monitoring and maintenance of civilian aircraft, ground vehicles, and stationary equipment.

REFERENCES: The activity responsible for the qualified product list is the Naval Air Systemns Command (Atten: Commander, Naval Air Warfare Center Aircraft Division, Code 41400B120-3, Lakehurst, NJ 08733-5100). Qualified Products List Of Products Qualified Under Military Specification MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft, Nato Code Number H-537.

KEYWORDS: Synthetic hydrocarbons; Silicate clusters; Polyalfaolefins (PAO); Some trade names like Brayco Micronic; Royco;Emery; Mobil Aero HFS; Aeroshell Fluid 31

N03-122 TITLE: Non-Intrusive Pressure Measurement System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS-450 Virginia Class Submarine

OBJECTIVE: Enable real-time non-intrusive measurements of steady and unsteady pressures on underwater complex configurations for performance and acoustics.

DESCRIPTION: Pressure sensors are currently used to make point measurements on a configuration (e.g. submarine/weapon/propulsor models) for performance or acoustic analysis. Such measurements are expensive and require instrumentation that is intrusive on the flow field or the model. Often, the most important aspects of the configuration cannot support such pressure ports (e.g., thin blade tip or leading edge). Hence, a non-intrusive pressure measurement technology is required to acquire this information. This technology will directly support propulsor and weapons design and submarine maneuvering and control objectives. Pressure sensitive paint (PSP) and thin-film MEMS are example non-intrusive pressure measurement technologies used in air for aircraft design and testing. Such capabilities are desired for underwater applications.

PHASE I: Proof of concept demonstration on a benign configuration. Compare analytical or measured steady pressures with non-intrusive technology in a water channel/tunnel over a range of static and dynamic flow environments.

PHASE II: Develop the complete non-intrusive pressure measurement system. Test in a water tunnel/channel. Document calibration and compare average and time-accurate pressures (~kHz) with pressure tap measurements.

PHASE III: Prepare complete system and user-documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Non-intrusive measurement systems for underwater applications can be used for laboratory and potentially at-sea measurements for hydrodynamic performance. Such systems can be useful for at-sea oil platforms, underwater NOAA vehicles, or any other underwater system.

REFERENCES: Proceedings of the 9th PSP workshop, 8-11 April 2002, Washington, DC.

KEYWORDS: Pressure; non-intrusive; hydromechanics; underwater measurements; acoustics.

N03-123 TITLE: Non-toxic / non-leaching antifouling coating

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop a coating or coating system that actively deters the settlement and fouling of marine organisms without the release of toxic metals or biocides.

DESCRIPTION: Marine biofouling is a significant problem on both ship hulls and heat exchangers resulting in increased fuel consumption, decreased speed/efficiency and also a vector for the transport of non-indigenous species. The majority of coatings prevent fouling through the slow and controlled release of toxins such as metals (tin, copper or zinc) and/or organic biocides. Novel approaches are sought that do not involve the use/release of toxic metals or biocides and in some way actively deter the settlement of potential fouling organisms. Alternatively, foul-release approaches will be considered in which the coating in some manner actively releases the attached organisms after the coating has become fouled. All approaches must give consideration to durability of the coating (e.g. a minimum of 7 years and preferably 12 years for a hull coating) and operational requirements (e.g. no reduction in the heat transfer efficiency for heat exchanger applications).

PHASE I: Develop a coating concept and prepare initial coatings on a small scale for testing, then test and demonstrate these initial coatings/concepts in the laboratory with in-house assays and collaborations with other investigators, as required.

PHASE II: Further development and scale-up of the proposed approach into a viable coating system. It is expected that through an iterative testing process, refinement and optimization of the coating will be accomplished by performing static immersion tests of panels for fouling measurements. It is anticipated that the final coating at the end of phase II will be equal to or better than the performance of existing coatings (e.g. copper-based paints) without adverse effects.

PHASE III: Prepare large panels for in-service hull panel testing that will be performed in cojunction with the Naval Sea Systems Command.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Anticipated international maritime regulations (MARPOL) will eliminate the use of tin-based anti-fouling coatings. The development of an effective truly non-toxic coating will provide an alternative that will comply with any future regulations that may limit/prevent the use of coatings which contain/release toxins of any type. These coatings should be applicable and of interest for both the commercial shipping and cruise liner industries, as well as for pleasure crafts.

REFERENCES: 11th International Conference on Marine Corrosion and Biofouling (www.marine2002.org)

KEYWORDS: Hull Coating; Anti-Fouling; Non-Toxic; Heat Exchanger; Biofouling; and Foul-Release.

N03-124 TITLE: Ship Hull Design and Performance

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS-325

DESCRIPTION: Conventional displacement hulls (e.g., monohulls) possess relatively high drag coefficients and consequently operate with limited efficiency. Multi hull designs with captured air plenums potentially offer less drag and hence greater operating efficiency. This is because the wetted area of the craft is reduced as air is captured at high speed. In addition, the captured air can mitigate shock from mines and, perhaps, improve seakeeping by reducing vibration. Some examples of this design have seen limited commercial use. Expansion of the concept to Navy use will require a re-evaluation of the fundamental hydrodynamics of the hull form.

PHASE I: Study the hydrodynamics of the captured air hull by means of advanced computational fluid mechanics (CFD). Explore how drag, lift, payload and seakeeping are affected by variation in body parameters such as hull length, hull spacing, fineness ratio etc. Develop an understanding of the benefits and drawbacks of the technology.

PHASE II: Design several advanced engineering hull forms using the understanding developed in Phase I. Incorporate likely requirements for missions of Navy relevance, such as minehunting, passive and active sonar, littoral combat etc. Analyze using CFD, paying particular attention to scaling phenomena. Select a design for later construction. Analyze structural and hydrodynamic performance of this design. Include seakeeping in the analysis.

PHASE III: Construct a prototype based on Phase II. Include an appropriate power train. Evaluate either in a large model basin or at sea. Compare and reconcile full-scale data with CFD predictions. Apply lessons learned to recommendations for Navy and commercial designs.

KEYWORDS: High-speed; multi-hull technology; ride quality; low wake; seakeeping; efficient hull.

N03-125 TITLE: <u>Real-time Distributed Detection of Damage to Shipboard Fluid Networks</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT I: DD(X)

OBJECTIVE: Develop and demonstrate a high-performance distributed system for real-time detection of damage (i.e., ruptures and leaks) in shipboard fluid systems.

DESCRIPTION: Current algorithms for detecting damage to shipboard fluid networks tend to provide poor tradeoff of probability of detection and probability of false alarm due to the use of crude tolerance envelopes based on simple models of parameter distribution. These techniques are characterized by poor receiver operating characteristic (ROC) curves and make little use of modeling of the fluid network under nominal operation and under failure, or adequately model the associated sensor characteristics. The performance of damage detection algorithms that rely on multiple sensor inputs is degraded, as inaccurate 'envelope' estimates prevent users from separating parameter drifts that are within specifications and system failures. A large number of techniques exist to model the statistics of the observable fluid system parameters and develop optimal or near optimal detection algorithms with better tradeoff than existing techniques. Among the modeling techniques are Monte Carlo methods as well as the Metropolis algorithm and Importance Sampling. Among the decision theoretic techniques are statistical detection theory (especially non parametric detection; jump detection algorithms; sequential detection techniques based on the algorithms by Wald and Lee and Thomas; and 'optimal stopping' methods), clustering techniques (especially agglomerative and 'soft' techniques) and supervised learning techniques (such as Kohonen networks and their variants). The purpose of this project is to determine which of these techniques, on a stand-alone basis or in combination with others (through integration and fusion) can provide real-time estimation of the required statistical models, and provide the most rapid and reliable detection of rupture(s) in shipboard fluid system. The overall distributed system should be capable of being ported to a fluid system outfitted with smart valves technology.

PHASE I: Develop real-time modeling and detection algorithm for fluid system damage detection. Model the algorithm and evaluate its performance using high-fidelity simulations of selected shipboard fluid systems. Compare parametric and non-parametric techniques, and evaluate the possibility of hybrids that include neural networks to augment classical detection theoretic algorithms.

PHASE II: Determine theoretical algorithm performance and compare against existing algorithms using data gathered from reduced-scale and/or full-scale fluid system test facilities. Develop and code a library of algorithms for field testing and evaluation. Installs distributed detection system on fluid test facility capable of simulating fluid system ruptures and leaks and evaluate tradeoff between speed and detection performance for selected algorithms.

PHASE III: Develop production versions of distributed detection system hardware and software components. Conduct field-testing of damage detection system on live-fire test and evaluation platform. Develop integration plan for implementing damage detection system into current and future naval surface combatants

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could in petroleum, chemical or other plants where the existence and handling of hazardous fluids would require the rapid and reliable detection of fluid network damage.

REFERENCES:

1. H. Vincent Poor: An Introduction to Signal Detection and Estimation, Springer, 1994.

2. David Siegmund: Sequential Analysis: Tests and Confidence Intervals, Springer, 1985.

3. Pramod Varshney: Distributed Detection and Data Fusion, Springer, 1997.

KEYWORDS: Jump detection; sequential detection; optimal stopping; non-parametric detection; damage control systems; false alarm; classification; clustering methods; data fusion.

N03-126 TITLE: Technology for Sensing Contaminants from Submarines

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics

OBJECTIVE: Develop new technology to detect contaminant profiles shed from submarine surfaces during normal deployment.

DESCRIPTION: Innovative technologies are being solicited for detecting contaminants that could be referenced back to submarines. Contaminants could be either biological or chemical in nature. These contaminants would be present at very low concentrations at 100's of meters below the surface open ocean and must be distinguishable from background levels under varying conditions. The technology proposed must be amenable to ocean environments and function at near real-time with sensitivities in line with contaminant dilution. The device emerging from the technology must be robust, reliable, long-lived and relatively inexpensive to build and deploy. In addition, the device must be amenable to existing deployment platforms.

PHASE I: Provide a description and overall design of the technology including the parameter to be measured and predicted sensitivity required of the technique for that parameter.

PHASE II: Develop a prototype device that encompasses the technology as described during the phase I period and demonstrate its ability to support measurements in an appropriate platform environment.

PHASE III: Develop and deliver a final testing apparatus for use by civilian and military testing laboratories.

COMMERCIAL POTENTIAL: As with all new instrumentation, the developed technology and accompanying device would have the potential to be used in a wide variety of commercial environmental monitoring systems

KEYWORDS: Oceanography, instruments, sensors, remote sensors, chemical, biological

N03-127 TITLE: Synthetic Androstene Derivatives and Natural Androstene Metabolites in Trauma

TECHNOLOGY AREAS: Biomedical

ACQUISITION PROGRAM: NAVMEDLOGCOM, MARCORPSYSCOM

OBJECTIVE: To confirm the hypotheses that androstene derivative and metabolite Immune Regulatory Hormones (IRH) will improve clinical outcome in swine with traumatic hemorrhagic shock (HS) (#1) by balancing harmful immune-activation and immune-suppression profiles in trauma (#2).

DESCRIPTION: Trauma and the associated systemic inflammatory response syndrome (SIRS) present a difficult medical challenge since patients suffer simultaneously from immunosuppression and excessive immunostimulation. SIRS is the consequence of a systemic, non-protective inflammation resulting from both reperfusion injury and endotoxin challenge. The cascade of events following traumatic injury are complex and incompletely understood. The most serious clinical features involve circulatory collapse and bacterial translocation from the intestinal lumen into the blood stream. Post injury therapy can also contribute to pathology through oxidation associated with reperfusion and massive release of endotoxin following antibiotics. A system wide, non-protective inflammation (thought to be primarily mediated by TNF-á and prostanoids/leukotrienes) initiates tissue damage, activates additional inflammatory cells, and results in further release of inflammatory mediators and tissue destruction. Vascular endothelium is also damaged in addition to organ parenchyma. Thus, neutrophil activation and adhesion follow, causing circulatory obstruction and hypoxia. Any re-establishment of circulation often results in reperfusion injury. The impact of all this “run away” inflammation on the microcirculatory system is devastating and creates a downward spiral of hypoxia and acidosis, all too frequently ending in multiple organ failure (MOF). Patients may die of MOF, with or without septicemia, even several weeks after stabilization from the initial insult.

Recently, the clinically and experimentally observed gender dimorphic response to traumatic injury has suggested the possibility of modulating cell and organ functions following trauma and hemorrhagic shock with sex steroids. Dehydroepiandrosterone (DHEA) is the most abundant steroid hormone secreted by the adrenal cortex. It is also the parent molecule of all sex hormones, including both androgens and estrogens. Observations in a variety of model systems have suggested DHEA provides benefit as a treatment for mock trauma (LPS and bacterial challenge), stress and age related immunounosuppression, and reperfusion injury. In bacterial and endotoxin challenge studies in mice, improved survival, decreased TNF-á and IL-1, and improved T cell function has been observed with DHEA and AED—a natural metabolite of DHEA. In burn injury and corticosteroid-mediated immune suppressive studies in mice, DHEA decreased susceptibility to infection, and traumatic hemorrhage, DHEA restored depressed splenocyte proliferation and IL-2, IL-3, and IFN-ã elaboration, by stimulating T cells and by preventing a rise in serum corticosterone. In traumatic hemorrhage studies in rats, DHEA improved hepatocellular and myocardial function. While the immunemodulatory, anti-inflammatory, and antiglucorticoid activities of DHEA have been fairly well characterized, less is known about DHEA metabolites and several synthetic congeners. Some of these immune regulating hormones (IRH), show similar or superior potency in rodents, in addition to possessing structural features that provide potential pharmacological advantages in humans. Improved survival in rodent challenge studies with viruses and malaria has been shown with IRH. These molecules represent a family of adrenal steroid metabolites and synthetic derivatives now under development with a broad pharmacological potential. Lead candidates are 16a-bromoepiandrosterone, 5-androsten-3b, 17b-diol, and 5-androsten-3b, 7b, 17b-triol, which are non-toxic, practically devoid of androgenic or estrogenic side effects, retaining powerful anti-inflammatory activity and the ability to restore immunological homeostasis rather than asymmetrically enhancing or suppressing either cell mediated (Th1) or humoral (Th2) immunity. Thus, the immunological activity of these compounds appears context specific; the very same molecule that attenuates chronic Th1 mediated inflammation in one animal and/or in vitro model system, often ameliorates aberrant Th2 responses in another. While the molecular basis for such activity remains unclear, it very likely involves context specific regulation of nuclear transcription factors such as NFkB and AP-1. IRH are thought to down regulate many pro-inflammatory cytokines such as TNF-á by action on this transcription factor. An important activity of IRH in this context is anti-glucocorticoid effects. IRH and glucocorticoids are thought to represent an endocrine-immune toggle operating via reciprocal regulation of NFkB. However, this does not imply IRH abrogation of the anti-inflammatory activity of glucocorticoids. Rather, it appears that IRH may prevent profound immunosupression that accompanies trauma while preserving the natural anti-inflammatory activity of cortisol release in response to endotoxin. Thus, these non-toxic, anti-inflammatory and apparent immune homeostatic properties of IRH make them ideal research candidates for primary and secondary prophylaxis against complications of trauma in combat.

This topic details preclinical research aimed at evaluation of the clinical and immunological effects of pre- and post-injury treatment of hemorrhagic shock casualties with IRH. In pathogen challenge studies, both pre- and post-challenge administration of IRH has been shown efficacy. Thus, both prophylaxis and therapy will be evaluated—first in rats and then in pigs with volume-controlled HS with associated soft tissue injury, and then in and uncontrolled hemorrhage model. Studies will be powered to show effects primarily on proportions of animals that survive. 2o outcome measurements will include other clinical parameters including assays of tissue and systemic oxygenation, base deficit, hemodynamic parameters, and organ-specific function. 3o outcome measurements will include immunological effects that will be assessed by collecting and processing PBMCs and plasma for analyses of immunological activation (CD4 or CD8 /CD44/CD69/CD71); intracellular and plasma cytokines (IL-1, IL-6, TNF) (ELISA and FACS); as well as PMN activation and adherence (CD11b, CD18, ICAM-1, E-selectin) and apoptosis markers (Bax/Bcl-2 ratio). 4o outcome measurements will be evaluated if 1o-3 o measurements are encouraging and will include immunohistochemical quantitative and qualitative analysis of tissue inflammatory infiltrates and apoptosis markers. In vivo correlates of antioxidant activity will be assessed by electrochemical detection of hydroxybenzoate hydroxylation to 3,4-dihydroxybenzoate [3,4-DHA] in intestinal effluent.

PHASE I: Phase I studies will consist of efficacy studies in rat HS models administering down-selected IRH both prophylactically and therapeutically (pre- and post-injury). Distinction between male and female efficacy will specifically be made. Studies will be designed to sequentially address the aforementioned outcome measurements—survival and clinical parameters, immunomodulation, and end-organ immunohistochemical and systemic function. Demonstration of efficacy in these exploratory studies—at least survival or other clinical parameters benefits—will establish justification and a milestone for progression to swine models to be evaluated in Phase II.

PHASE II: In swine, Phase II studies will systematically and methodically confirm IRH efficacy demonstrated in rat studies in Phase I. Again, both prophylactic and therapeutic dosing will be evaluated. In both volume-controlled and uncontrolled HS models with associated soft tissue injury, pharmacokinetic pharmacodynamic, and safety studies will be conducted to optimize and further down-select optimal IRH candidates. Distinction between male and female efficacy will specifically confirmed. Studies will be designed to sequentially address the aforementioned outcome measurements—survival and clinical parameters, immunomodulation, and end-organ immunohistochemical and systemic function. These experiments will form the basis for subsequent Phase III clinical studies.

PHASE III. Demonstration of improved outcome of traumatic hemorrhagic shock casualties by IRH will allow for rapid clinical evaluation and should provide a cost-effective and easily commercialized therapeutic adjunct.

PRIVATE SECTOR COMMERCIAL POTENTIAL: An improved ability to control the negative sequelae of trauma will help saves lives in both the civilian and military sectors.

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2. Freilich D et al. 16a-bromoandrosterone, a DHEA analogue, inhibits Plasmodium falciparum and Plasmodium berghei growth. AJTMH 63:280-283, 2000.

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KEYWORDS: hemorrhagic shock, trauma, androstene, Immune Regulatory Hormones

N03-128 TITLE: Neurologic and Cognitive Outcome after Resuscitation of Casualties with Whole Blood-like Blood Substitutes

TECHNOLOGY AREAS: Biomedical

ACQUISITION PROGRAM: NAVMEDLOGCOM, MARCORPSYSCOM

OBJECTIVE: To improve acute and subacute neurologic and cognitive outcome in combat and civilian rural hemorrhagic shock (HS) casualties with and without concomitant traumatic brain injury (TBI), by developing and evaluating whole blood-like blood substitute prototypes.

DESCRIPTION: Because rapid exsanguination and brain injury account for 50% and 36% of battlefield fatalities, respectively, immediate restoration of blood volume and O2 content may be lifesaving. However, rapid and safe blood transfusion and expeditious evacuation for definitive surgical care are unavailable for many operational and rural civilian casualties. Furthermore, the fire-fights in Mogadishu and Eastern Afghanistan have shown that delayed evacuation (characteristic of the current asymmetric battlefield) may necessitate maintenance of cognitive function and some fighting ability even in injured combatants -e.g. an isolated femoral or iliac vascular injury with severe but controlled blood loss. The pre-evacuation standard of care for HS casualties with concomitant TBI relies on extrinsic hemostasis (often not possible) and resuscitation with crystalloid/colloid solutions to ensure adequate cerebral perfusion. Coagulopathy, thrombocytopenia, and platelet functional defects cause further hemorrhage, hypotension, intracranial bleeding, and worsening neurologic outcome. Complications of free radical generation and immune activation after resuscitation may cause neuronal reperfusion injury leading to further delayed morbidity. Thus, whole blood, with its volume, O2-carrying, hemostatic, and antioxidant properties, would be an "ideal" resuscitative fluid if logistic hindrances of refrigeration and ABO incompatibility were to be overcome. It can be predicted that immediate availability of a whole blood-like blood substitute in the field will decrease morbidity and mortality and may increase cognitive performance of the severely injured combatant pending evacuation for definitive care, allowing maintenance of some fighting capability. This topic details preclinical research aimed at evaluation and optimization of the neurologic and cognitive effects of novel 4th generation whole blood-like prototypes with improvements in efficacy breadth and side effect profile, for the resuscitation of HS casualties with and without TBI. Initial prototype components will be derived from small businesses and research institutes. Prototype characteristics will include volume expansion and good O2 carrying and release, storage stability without refrigeration at high and low extremes of ambient temperature, as well as hemostatic and antioxidant properties. The potency and thrombogenicity (safety) of procoagulant and/or platelet-like activity of the prototype will be assessed with and without induced coagulopathy and thrombocytopathy. Furthermore, recently, hypotensive resuscitation with traditional intravenous fluids (and possibly with hemoglobin based O2 carriers) has been shown to decrease mortality in uncontrolled HS and has been adopted by the US military. However, the effect of hypotensive resuscitation on neurologic outcome with concomitant TBI is not well described and is unknown for resuscitation with a whole-blood like blood substitute. Therefore, in invasively monitored animal models, normo- and hypotensive resuscitation with the prototype will be assessed. Studies will be powered to show effects primarily on proportions of animals with normal neurologic and cognitive function and time to normal function. Functional neurologic and cognitive outcome will be evaluated acutely and subacutely using standardized animal scales. Secondary and tertiary outcome measurements might include histopathological assessment of infarction size, brain tissue oxygenation, intracranial hematoma volume, survival, and immunohistochemical markers.

PHASE I: Evaluate the whole blood-like prototype in standardized severe volume-controlled HS animal models with superimposed soft tissue +/- penetrating TBI. The aim of these exploratory studies will be to demonstrate improved and rapid neurologic and cognitive outcome, and decreased intracranial bleeding and brain infarction size. These studies will set the stage for subsequent preclinical optimization studies.

PHASE II: Systematically and methodically confirm the efficacy of the whole blood-like prototype for improving neurologic and cognitive outcome after sustaining traumatic HS +/- TBI. More clinically significant uncontrolled HS models will be studied with superimposed induced coagulopathy, thrombocytopenia, and functional platelet defects. The prototype will be compared with its individual components and traditional intravenous fluids in both hypotensive and normotensive resuscitation strategy models. Detailed brain radiological, histopathological, and immunohistochemical studies will be completed to delineate the therapeutic potency of the prototype. Additional modifications may be made in the prototype to augment its efficacy/toxicity profile including vasoactivity, oxidation, and immune modulation. These brain injury/neurologic outcome studies will complement other HS studies funded through other sources, and will form the basis for demonstration of the prototype's neurocognitive efficacy/toxicity profile for subsequent clinical trials.

PHASE III. Development and optimization of an immediately available whole blood-like blood substitute prototype will provide a logistically feasible prehospital resuscitation strategy to improve 1) Warrior Readiness, including continued ability to fight, and 2) neurologic outcome in combat casualties as well as civilian rural patients who suffer traumatic HS and TBI. Phase II studies, in addition to other non-neurologic outcome studies on the whole blood-like blood substitute prototype, will allow for submission of an Investigational New Drug application (IND) to the FDA for evaluation in Phase III clinical studies.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A successful project would lead to an advanced blood-like prototype, with known effectiveness and side effects, for the life-saving treatment of casualties in remote military or civilian environments. The prototype could be commercialized for the resuscitation of HS casualties, with and without TBI.

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2. Bellamy RF. The causes of death in conventional land warfare: implications for combat casualty care research. Mil Med 149:55-62, 1984.

KEYWORDS: hemorrhagic shock, traumatic brain injury, blood substitute, neurologic and cognitive outcome

N03-129 TITLE: Human Activity Recognition

TECHNOLOGY AREAS: Sensors, Human Systems, Nuclear Technology

OBJECTIVE: Enable multi-sensor surveillance systems to recognize patterns of behavior activity occurring at ports and on naval facilities, where security personnel can easily specify spatio-temporal activities of interest or have the system learn them from examples.

DESCRIPTION: Current security/surveillance systems depend on human operators looking at banks of screens with sensor/alarm outputs and CCTV imagery, requiring constant attention by these operators to notice any suspicious patterns of activity. Lapses in attention, or simply the sheer overwhelming number of sensors to monitor for a large and active facility hampers the efforts of human operators. With the increasing levels of security the number of sensors, both imaging and non-imaging, will be dramatically increasing. Advances by the research community on video surveillance have moved well beyond basic video "motion detection", to develop techniques for geo-spatial localization, automated vision-based target tracking and multi-sensor hand-off and control, and is beginning to develop basic activity recognition. To maintain effectiveness of surveillance systems, research is needed to develop a system that can automatically detect patterns of activity which would increase security while freeing security personnel to spend more time on threat assessments and actual interdiction. The range of activities of interest is, however, not easily determined, the system must be highly "programmable" by security personnel who will generally have only minimal computer experience. Research is sought that exploits emerging research in human activity recognition, yet builds upon existing commercial-off-the-shelf hardware and communication techniques to create a system design that will be both useable by security personnel and extensible to new sensors and algorithms.

PHASE I: Develop a design for a trainable semi-automated system for activity recognition. The system should be geo-spatially oriented, capable of handling the full spectrum of basic security sensors (e.g., magnetic, microwave, passive Infrared) as well as video motion detection, and it must be capable of learning behaviors from examples at the actual facility. It should also provide a graphic user interface for end-users to specify new patterns of activity that are considered significant. Behaviors should include multiple interacting humans, humans interacting with vehicles and multiple vehicle activities.

PHASE II: Develop a prototype activity recognition system for demonstration. The prototype module must provide for the integration of several different types of port security sensors, such as radar, pan-tilt thermal imaging sensors, monitoring a physical area exceeding one sq.km. of land and two sq.km of water.

PHASE III: Demonstrate this system at a harbor facility, with objective performance measures including detection, tracking, human performance aiding and ease of use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advances in this technology could have a broad impact on security and surveillance systems in all areas including commercial port security, general facility/infrastructure security, Mall and parking-lot security. Electronic security is already a billion dollar a year market and still growing rapidly.

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KEYWORDS: video surveillance, activity recognition, force protection, sensors

N03-130 TITLE: Human Error Modeling

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: A state-of-the-art human-performance modeling tool for human-system interaction design capable of modeling both correct and erroneous performance.

DESCRIPTION: Although human error has been implicated in countless accidents and tragedies, it is rarely the end of the story. Often, the root cause of human error can be traced to poor system design. Error-prone systems marginalize overall operational effectiveness, cost more to operate and maintain, and require longer training times for operator proficiency. Error-tolerant systems prevent and reduce common errors, assist in the detection and identification or errors that do occur, and assist the user in error correction and recovery. Modeling human use of military systems early in their design phases can help design human error out of these systems long before production even starts. Typically, modeling tools can either represent correct performance only, or can model human error at a very coarse level. Computational cognitive architectures represent a promising technology for developing a sound, psychologically-principled approach to modeling human error. This effort will develop a modeling system that can create high-fidelity engineering models of human performance to assist in the design of error-tolerant systems.

PHASE I: Identify critical system components, define use cases and usability requirements, and develop a system design and prototype for modeling erroneous human performance.

PHASE II: Implement the human-error modeling system, demonstrate its use on a real design problem, and evaluate its usability. Identify action patterns likely to cause human error; map identified human errors to design guidelines and error recovery.

PHASE III: Prepare system and methodology training documentation for system designers and human factors professionals. Attach to advanced development or procurement program to further evaluate and refine system use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be used for any complex system design in which human error is a critical performance factor, such as, medical, military, intelligence, financial, or homeland security.

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KEYWORDS: System design; human error; human-system interaction; error-tolerant design; analysis; cognitive.

N03-131 TITLE: Advanced Helmet Systems Umbilical Interface

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: NAWC/4.6T, PMA-202: Aircrew Systems Program

OBJECTIVE: Provide a flexible, high information rate umbilical interface for emerging aircrew helmet-mounted systems that supports the "information explosion" in the cockpit and enhances efficient aircrew/system interface across an expanded pilot population.

DESCRIPTION: As the capabilities of head-mounted systems progress to high definition displays and increased resolution of head-mounted night vision sensors, increased aircraft mission requirements, sophisticated head/eye tracking and increased physiological monitoring technologies, there is an increased demand on the helmet cabling safety interface. These demands create severe head-supported weight and cable stiffness challenges which restrict head motion. There is a need for an alternative system to convey signals to and from the head, which will reduce the conductor count, increase operational bandwidth, and improve the utility of this vital aircrew interface.

PHASE I: Evaluate practical alternatives to the "all copper" common helmet-vehicle interface used currently by the Services for helmet system safety interface. Identify potential technologies and the advanced design concept for the next generation helmet system interface. Design the desired system.

PHASE II: Develop a proof-of-concept helmet system interface capable of conveying binocular high definition display information, dual-channel night vision, hybrid head/eye tracking, 3-D audio, and physiological monitoring information to/from the head. Conduct proof of performance testing in a laboratory environment.

PHASE III: Provide complete system specification and performance oriented test criteria associated with ejection, rapid ground egress, and helmet loss aspects of the total system in support of technology transition.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology would be directly usable in applications such as law enforcement, fire fighting, medicine and competitive racing where various head-mounted technologies are increasingly being utilized.

REFERENCES: Clark T., Hollis, D., King, G., “An Integrated Approach to Safe Helmet-Mounted Display/Vehicle Interface” 1995 SAFE Association Symposium Proceedings

KEYWORDS: Quick-Disconnect, Interface, Helmet-Mounted Display, Helmet-Vehicle Interface, Connector, Cabling

N03-132 TITLE: Pilot Behavioral Modeling for Flight Operations Near Ships

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop pilot behavioral models that will conduct simulated shipboard approach, landing and take-off maneuvers for conventional fixed wing, STOVL and rotary wing aircraft, using realistic control strategies that respond to ship airwake and ship motion effects.

DESCRIPTION: Manned simulations of aircraft operating to ships provide significant savings in time and cost through enhanced shipboard pilot training, as well as test & evaluation of ship-aircraft combinations. Off-line simulation of shipboard operations offers further savings, by being able to evaluate a ship-aircraft pair, without the need for more expensive manned simulation. This would be of greatest benefit to the ship or aircraft designer, providing the ability to test designs prior to build. Such a capability is currently an objective of the NAVAIR SAFEDI (Ship Aircraft Airwake Analysis For Enhanced Dynamic Interface) program, sponsored by ONR. However, off-line analysis is hampered by the lack of pilot behavioral models that will fly the aircraft to the ship, land on it and take off again, using realistic control strategies. While pilot modeling for aircraft simulation is not a new concept, pilot modeling for shipboard operations is particularly challenging because of the dynamic environment, including the effects of the ship's unsteady, turbulent airwake, and ship motion. Furthermore, the high gain nature of the task means that different pilots adopt different control strategies, and achieve different levels of performance, depending on skill, experience and technique. Innovative pilot behavioral models are required that will closely replicate the control inputs of a typical pilot operating an aircraft (conventional fixed wing, STOVL and rotary wing) near to a ship, producing a similar level of performance. Airframe models will be specified by NAVAIR. User-selectable parameters will enable the characteristics of the pilot models to be modified to represent the control strategies of different pilots. The pilot models will be integrated in shipboard simulations using the NAVAIR airwake and NAVSEA ship motion models, and will be validated against existing at-sea flight test data, to show that the predictions are representative of the responses of typical pilots.

PHASE I: Develop and validate simple pilot models to predict the control activity required for a rotorcraft and for a conventional fixed wing aircraft to approach, land on, and take off from a ship.

PHASE II: Enhance the pilot models to predict realistic responses to ship motion and airwake effects, and to enable different control strategies to be represented. Develop a pilot model for STOVL aircraft. Integrate the pilot models in a shipboard simulation and validate against existing at-sea flight test data for a fixed wing and STOVL aircraft operating to a large ship and a rotorcraft operating to a small ship.

PHASE III: Upon validation of the pilot models for each aircraft/ship combination, the tools can be transitioned to industry and government to predict and enhance shipboard performance for current and future aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The modeling tools developed to predict pilot behavior could be used for simulation of commercial aircraft such as coast guard, police, and medivac aircraft in order to enhance handling qualities in high gain tasks, particularly in turbulent environments near ships, oil rigs and buildings, and in mountainous regions. The result would be increased safety by identifying possible hazardous areas before the aircraft will encounter them in real life. The tools would also improve platform design, whether ship, aircraft or landing zone, by evaluating potential aircraft and pilot performance prior to build.

REFERENCES: Advani, S.K. & Wilkinson, C.H., 'Dynamic Interface Modelling and Simulation – A Unique Challenge'. Paper presented at the Royal Aeronautical Society conference 'The Challenge of Realistic Rotorcraft Simulation', 7-8 November 2001, London, UK.

KEYWORDS: pilot; aircraft; ship; airwake; control; model

N03-133 TITLE: Water Tight Surface Geometry From IGES, CAD and STEP Files

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Generate a set of surfaces that define a watertight object from any native Initial Graphics Exchange Specification (IGES), Computer Aided Design (CAD), STandard for the Exchange of Product data (STEP) , and polygon geometry definitions

DESCRIPTION: Manned simulations of aircraft operating to ships provide significant savings in time and cost through enhanced shipboard pilot training, as well as test & evaluation of ship-aircraft combinations. Off-line simulation of shipboard operations offers further savings, through evaluation of a ship-aircraft pair, without the need for more expensive manned simulation. This would be of greatest benefit to the ship or aircraft designer, providing the ability to test designs prior to build. Such a capability is currently an objective of the NAVAIR SAFEDI (Ship Aircraft Airwake Analysis For Enhanced Dynamic Interface) program, sponsored by ONR. A component of the SAFEDI program is to model a range of Navy ships, in order to calculate their airwake. Currently the modeling of a Navy ship is a very labor intensive and time consuming process, even with a well defined ship in an IGES file.

Many problems can be encountered when working with an IGES file. The format may be different than the IGES format of the program being used to model the object. The IGES file may contain many layers of information, only several of which are actually being used to generate the object. The program used to model the object does not model trimmed surfaces. Surfaces defined in the IGES files do not abut. In order to model the object all surfaces are required to abut, or to use the correct terminology the surfaces are required to make a watertight object.

A computer program is needed that reads any IGES format, STEP (STandard for the Exchange of Product data) file, and any native CAD file without a license for the CAD program. The computer program should generate a set of surfaces that define a water tight object and save this information in either a surface format like plot3d or in an IGES file using a specific set of entities. The set of surfaces can be either structured or unstructured. The program should identify and fix any problems such as surfaces not abutting and provide an error estimate both numerically and graphically about how the new surfaces differ from the original geometry. Object detail can be deselected based on volume or other parameters. This would allow CAD, etc. files to be “cleaned” of small objects such as rivets, etc.

Our requirements are as follows:

-Read IGES, STEP and native cad files.

-User interaction will be through a gui interface, with mouse and keyboard.

-IGES, STEP and native cad files could contain a complex aircraft or ship.

-Allow user to select a set entities that make up a subset of the ship or aircraft, e.g. a wing.

-Fit a surface or set of surfaces through the selected entities, the entities may have gaps between them or they might overlap.

-New surfaces should be highlighted to distinguish them from the original entities.

-New surfaces should abut.

-Graphically and numerically display the differences between the original entities and the new surfaces.

-User should be able to interact with the new surfaces to adjust the fit, maybe through control points on the new surfaces and/or on the boundary of the new surfaces.

-User should be able to interactively select/deselect entities that the surfaces are fitted through.

-User will continue by selecting additional sets of entities for fitting of surfaces.

-Final step will be to specify that all the new surfaces will abut in order to form a water tight surface of the original aircraft or ship (probably want to give the user the ability to specify which surfaces will abut and which surfaces to be abutted to).

-New surfaces will be written in both IGES and STEP formats. The IGES format will be compatible with the current versions of the grid generators GRIDGEN and (NASA Langley) GridTool. We would prefer the new surfaces be stored as NURB surfaces.

PHASE I (Feasibility): Demonstrate fitting a surface through a set of IGES entities that make up a simple shape. Some entities will have gaps between them and some entities will overlap. The simple shape will be made up of convex and concave parts, maybe a straight wing with a concave airfoil shape. Demonstrate user interaction with the fitted surface. Output the final surface as an IGES entity, preferable a Nurbs surface.

PHASE II (Prototype): Use a more complicated starting cad object, a simple aircraft or ship. Again the object will be made up of some entities that overlap and some entities that have gaps between them. Demonstrate that all the requirements can be met.

PHASE III (Implementation): Demonstrate all the requirements are met for at least two complex ship configurations and two complex aircraft configurations.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A variety of analysis tools would benefit from starting with a watertight surface geometry. The applicability would include CFD and finite element analysis.

KEYWORDS: CAD; watertight surface; IGES; IGES entities; plot3d surface format

N03-134 TITLE: UAV Metric Sensor Suite

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: To develop a metric UAV and/or helicopter sensor suite that will support photogrammetric applications as well as targeting and surveillance operations.

DESCRIPTION: In order to be suitable for photogrammetric applications, a sensor must be metric in the sense that a stable sensor model can be developed and calibrated, and that its position and attitude can be precisely determined. A UAV typically has a very limited payload capacity and can be subject to a great deal of turbulence, while a helicopter can present a high vibration environment. These types of environments have largely precluded the employment of metric sensor systems on these types of platforms. The desired metric sensor suite will need to have both visible and IR modes with a stepped zoom capability (continuous zoom is largely incompatible with the metric requirement). A large image format (2000 by 2000 pixels per frame or larger) is desirable. It will need to be extremely stable in pointing. Tight coupling of differential GPS and an Inertial Navigation System (INS) will be needed to provide 10cm sensor positioning and sensor attitude determination to better than 300 microradians. Thermal control will be an additional issue that must be addressed.

PHASE I: Develop a system design that addresses sensor integration, GPS/IMU integration, and stability and calibration issues. Bench test key components.

PHASE II: Prototype and flight test a metric sensor suite. Develop sensor models and calibrate sensors. Validate design specifications and sensor metric stability.

PHASE III: Develop complete sensor suite.

COMMERCIAL POTENTIAL: This hardware capability would have a ready market as an upgrade to the numerous helicopter borne imaging systems used by many television stations. It would also have significant commercial potential in the airborne photogrammetry industry.

REFERENCES: “Elements of Photogrammetry”, by Paul R. Wolf, McGraw-Hill, New York, NY, 1983.

KEYWORDS: Targeting, Video, Electro-optical, Stereo Imagery, Photogrammetry.

N03-135 TITLE: Advanced across-sensor geospatial applications to support battlefield preparation

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a robust collection of techniques capable of maximizing the collective utilities of passive and active imagery assets to support joint service battlefield preparation. Particular interest regards the use of advanced commercial spaceborne and airborne sensors to support Navy responsibilities under the joint fires mission.

DESCRIPTION: The use of imagery assets to support US military operations has been a research topic for decades. Recent advances in resolutions (i.e., spectral, spatial, radiometric, and temporal) have reached sufficient levels where commercial sources (e.g., QuickBird, Radarsat, digital airborne metric, UAV sensors, and others) now offer direct support specialized military applications. Among others, the US Navy – under a joint service effort -- has interest in leveraging the collective utilities offered by these systems to support battlefield preparation. The key is to use these data in the context of modern military operations and this demands advanced understanding of methods, applications, and procedures paired against current and future requirements. Benefits in using commercial data can also be increased further when they are combined with military resources to form comprehensive and dynamic area-of-interest coverage.

Previous investigations typically focused on using these resources either as separate inputs, in isolation, under narrow "fusion" applications, or with emphases on manual/visual analysis. Such approaches have not adequately leveraged the collective military utility of these data in support of current and future operations and requirements. Instead, the intent herein is to develop a solution capable of exploiting these imagery resources for the explicit purposes of supporting joint service battlefield preparation. Emphasis must be placed on new and advanced imagery processing/geoprocessing tools capable of using the data as comprehensive compliments towards satisfying specific CONOPS requirements in such areas as elevation/surface modeling, tunnel detection, target detection, tracking, geo-location, and defeat of CCD practices. Any proposed approaches must be capable of quantitatively modeling the contribution of the respective sources towards satisfying explicit battlefield preparation requirements. An assessment of drawbacks is use of the data must be included as part of the research.

PHASE I: Develop the needed methodologies and plans for a prototype capable of exploiting various commercial imagery resources within the context of current and future joint service battlefield preparation CONOPS and related requirements. Particular emphasis in on Navy responsibilities under the joint service mission.

PHASE II: Prototype a complete solution that provides improved capabilities with respect to all the issues listed above and demonstrate this using commercial satellite/airborne imagery within the context of geospatial processing schemes.

PHASE III: Develop a complete software package including user documentation for use as a stand-alone application or as an embedded application within larger commercial/military systems.

COMMERCIAL POTENTIAL: Given the increasing interest in remote sensing and geospatial processing capabilities across both industry and government the potential of a successful commercial product is both compelling and timely. This is demonstrated further by the fact that existing users eagerly need solutions capable of providing the tools described above. Namely, the solution could be used by: state and local governments interested in utilizing complimentary aspects of modern commercial sensors; the private sector to support smart land development practices; large-scale agricultural programs responsible for improved land use procedures; and time-critical emergency response organizations. The ability to examine quantitatively the contribution of each type of data input would be a particularly appealing capability as a means for improving the reliability of geoproduct production generation and services.

REFERENCES:

1. Nicholson, R. V. 2001. "GIS Imaging Integration." Advanced Imaging. November, p. 32.

2. Jensen, J. R. et al., 1994. "Improved Urban Infrastructure Mapping and Forecasting for BellSouth Using Remote Sensing and GIS Technology." PERS, 60(3), pp. 339-346.

KEYWORDS: Commercial imagery; Battlefield preparation; Navy CONOPS, Advanced geoprocessing, Joint service, Multiple imagery sources

N03-136 TITLE: <u>Individual Combatant (IC) Weapon Firing Algorithm for a Military Operations in Urban Terrain (MOUT) Environment</u>

TECHNOLOGY AREAS: Information Systems, Human Systems, Weapons

OBJECTIVE: Implement and validate weapons firing and suppression algorithms for individual combatants operating in a MOUT environment.

DESCRIPTION: Across the services, researchers have developed training systems in virtual environments that require models of individual humans engaged in combat with direct fire weapons [1] [2] [3]. Effective emulation of this type of behavior requires advancements in a number of representation technologies including threat detection, situation awareness, movement and posture dynamics, terrain reasoning, and weapons firing. Human performance data will be used to implement and validate a weapons firing and suppression algorithm for individual combatants training in a MOUT environment.

The subtleties of weapons firing and suppression have been studied in [4] and [5]. Specifically, [4] has developed methodology to define weapon firing algorithm based on use of human performance data coupled with introspective data collected from SMEs. The challenge is to use data such as these to fully implement the weapon firing algorithm, as well as to validate that algorithm. This implementation should be executed in such a way and robust to the extent that the algorithm may be applied to a variety of constructive environments supporting IC mission rehearsals in MOUT environment.

PHASE I. Implement an IC weapon firing algorithm in MOUT environment based on behavioral and scientific modeling strategies, including a description of the metric to be used to indicate the validity of the implemented model.

PHASE II: Validate the model to embody complete functionality of the components being demonstrated; provide complete documentation of the test cases and the validation results.

PHASE III: The IC weapon firing algorithm will be demonstrated in the ONR VIRTE program, and other military applications. It will also have strong commercial potential with law enforcement and security agencies such as FBI, DEA, and the Secret Service; NATO and allied military sales; and the computer game industry. In addition, this technology could be deployed on robotic vehicles, such as the Army FCS.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology will apply to law enforcement, security and military training and simulation needs, as well as entertainment.

REFERENCES:

1. Wray, R.E., and Laird, J.E. (2002). Intelligent Opponents for Virtual Reality Trainers. To be published in Proceedings of I/ITSEC 2002.

2. Reece, D. A., Kraus, M. K., et al (2000). Tactical Movement Planning for Individual Combatants, Orlando, FL. Simulation Interoperability Standards Organization.

3. McDonald, B., Weeks., H., Hughes, J. (2001). Development of Computer Generated Forces for Air Force Security Forces Distributed Mission Training. Proceedings of I/ITSEC 2001. Orlando, FL.

4. Henninger, A., and Taylor, G. (2002). Development of Individual Weapons Firing Algorithm for Individual Combatants in MOUT Environment, unpublished manuscript.

5. Middleton, V., D'Enrico, J., Christenson, W. (199X). Simulation of Suppression for the Dismounted Combatant. Proceedings of 5th Conference in Computer Generated Forces and Behavior Representation. Orlando, March, 1997.

KEYWORDS: individual combatant, weapons firing, target selection, weapon selection, suppression

N03-137 TITLE: Aluminum-Air Fuel Cell/Battery Research

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective of this SBIR topic is to explore opportunities for further enhancing the specific electrical energy (energy per unit weight) of aluminum-air fuel cells/batteries.

DESCRIPTION: Dismounted Marines operating in remote locations will have increasing requirements for portable electric power. Although current power use is dominated by radio communications, future use is likely to involve numerous additional devices as well. Current needs are generally met with LiSO2 (BA-5590) primary batteries. As such, this battery constitutes a reasonable baseline against which to measure the performance of alternative systems. Since dismounted units must carry all components of any power source, specific energy (measured in watt-hours per kilogram) is frequently the most important attribute. Specific power is also important, but relatively low duty cycles at peak power may permit efficient buffering via short-term storage devices.

Aluminum-air cells have an extremely high theoretical specific energy. However, actual performance has been considerably more modest, due largely to adverse reactions and inefficiencies at and near the anode surface. In fact, the disparity between theoretical potential and practical performance for such devices is so great that even modest gains in electrochemical efficiency could significantly enhance their overall performance. For example, a novel composite anode structure might allow greater effective metal surface/electrolyte contact area for increased current capability. Additionally, aluminum-air cells offer the possibility of rapid field recharging via anode and electrolyte replacement, thus minimizing overall weight for extended missions. Unlike many other power sources, aluminum-air cells are essentially environmentally benign.

This SBIR topic will investigate novel approaches for practically realizing a greater portion of the theoretical specific energy of aluminum-air cells. It will also demonstrate any enhancements in a prototype device.

PHASE I: Phase I will refine the experimental approach and initiate experimental efforts. The conclusion of phase I should provide a reasonable basis for assessing the upper and lower electrical performance bounds achievable via subsequent optimization in Phase II.

PHASE II: Phase II will continue the investigation into optimizing electrochemical efficiency and would culminate in the fabrication and testing of a working bench-top prototype device capable of rapid recharging via anode and electrolyte replacement as necessary. The prototype would consist of an aluminum-air fuel cell/battery which is configured to match at least the weight and nominal voltage of BA-5590 battery mentioned above. Primary emphasis would be placed on optimizing the specific energy, with secondary emphasis on specific power. If necessary, the prototype may be shaped to optimize airflow at the cathode.

PHASE III: If the performance of the Phase II prototype offers significant advantages over alternative technologies Phase III would be pursued. It would consist of designing, fabricating and testing five prototypes suitable for field evaluation, and would be funded via USMC 6.3 funds. If necessary, Phase III may also include the integration of a short-term storage device to meet peak power requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial potential for the specific field rechargeable device studied under this SBIR is probably limited. This is because it would most likely be designed to emphasize military operational efficiency at the expense of consumer convenience (Recharging would involve anode and electrolyte replacement). However, even moderate advances in the overall electrochemical efficiency of aluminum anodes achieved via this effort could significantly alter the relative merits of aluminum-air cells in the battery market.

REFERENCES: Handbook of Batteries (Second Edition), D. Linden, Editor, Chapter 38 (38.4), McGraw Hill, Inc., New York (1995) and cited references within.

KEYWORDS: Battery; Fuel Cell; Aluminum-air; Electric power

N03-138 TITLE: Unmanned Aerial Vehicle for Magnetic Sensing

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 264 – Air Anti-Submarine Warfare (AASW) Systems

OBJECTIVE: Tactical unmanned aerial vehicle (TUAV) for high performance magnetic sensing

DESCRIPTION: Magnetic sensing for Air Anti-Submarine Warfare (AASW) has traditionally been conducted from tail booms of fixed-wing manned aircraft or towed from helicopters. Maximized spatial separation of the magnetic sensor from the aircraft electrical systems has been a critical factor to effectively realize the intrinsic performance of the magnetic sensors. High performance magnetic sensing onboard tactical unmanned aerial vehicles (TUAVs) represents a valuable capability as the role of TUAVs grows for future Fleet AASW operations. Aircraft in general and TUAVs in particular are typically designed without concern for magnetic signature management. On a positive note, the nature of UAVs allows considerable flexibility in design and selection of subsystem components as compared to manned aircraft such as the P-3 Orion or the H-60 helicopter. In particular, UAV engine types can be selected to minimize their magnetic moment and noise contribution. The body frame and layout of critical subsystems can be designed to position the magnetic sensor well separated from the vehicle's electrical subsystems. The vehicle should also be designed for convenient deployment and retrieval by the Fleet. The vehicle should be designed to allow multiple sensor and multiple mission packaging to expand its utility for Fleet application. In particular, there is interest in using the proposed TUAV for fused magnetic and optical sensing so that the design should include a payload section to accommodate standard electro-optic and/or hyperspectral imaging packages. While the primary requirement for this TUAV is for AASW, it may also be used for the detection of land-based underground facilities and heavily camouflaged assets conducted in low-level flight over land. Since the vehicle would be subject to ground fire in this application, signature-reduction design features are desirable to reduce vulnerability.

PHASE I: Develop and document concept and preliminary design for TUAV capable of high performance magnetic sensing.

PHASE II: Develop critical design and manufacture exploratory development prototype of TUAV capable of high performance magnetic sensing. Conduct flight testing of this prototype integrated with GFE high performance magnetic sensors.

PHASE III: Manufacture engineering development prototype of TUAV capable of high performance magnetic sensing and deployment from Fleet assets. Support Navy demonstration of TUAV prototype with GFE high performance magnetic sensors.

PHASE III DUAL USE APPLICATIONS: In addition to AASW, this technology can be used for sea mine countermeasures and for detection of land-based underground facilities and heavily camouflaged assets as required by all branches of the military, as well as other government agencies including intelligence and counterdrug units. This technology could eventually be applied to geophysical research, oil and mineral exploration, environmental cleanup, and underwater search and recovery missions.

REFERENCES:

1. Littoral Antisubmarine Warfare and Autonomous Operations Documents, in Office of Naval Research Science and Technology Future Naval Capabilities
website http://www.onr.navy.mil/sci_tech/futurenaval.htm.

2. Air ASW Technology Needs Document, in National Defense Industrial Association Undersea Warfare website http://www.ndia.org/committees/usw/index.cfm.

KEYWORDS: unmanned aerial vehicles; antisubmarine warfare; magnetic sensing; autonomous operations; hidden facility detection; signature reduction

N03-139 TITLE: Over-the-Horizon Communications for Small Autonomous Ground Based Observations

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM:

OBJECTIVE: Develop miniature communications technology for use in over-the-horizon transmission of data from small autonomous ground based sensors.

DESCRIPTION: There is a need for the capability to transmit data from various types of ground based sensors such as biological/chemical, meteorological, audio/video surveillance, communication monitoring/decoying and vehicle/personnel movement sensors. Using the latest technology, miniature versions of some of these sensors already exist and others are in development or are being planned. Both deployment and operation of these sensors are generally required to be covert. The sensors must be small in size and must transmit their information to users located at considerable distances from the sensor. In the future it may be possible to covertly deliver sensors by air from high altitude, long standoff distances using precision air drop modules deployed from standard military aircraft countermeasures dispensers. This will require development of sensors packaged in extremely small form factors compatible with standard flare and chaff payloads. Development of a miniature over-the horizon communications module will be required for use in these sensors. This module must be capable of transmission of data to users without the necessity of aircraft over-flights or ground personnel being in close proximity to the sensors. The modules must be extremely small in size, and power efficient. Burst transmission of data at high data rates will be required to limit transmission time for purposes of preserving power and reducing chances of intercept and location by the enemy.

PHASE I: Investigate new technology related to miniature communications electronics and long distance data transmission, including both direct and satellite relay technologies. Report attractive design concepts.

PHASE II: Develop and demonstrate miniature communication module prototypes. Develop a commercialization plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition prototype to commercial product for military/scientific use.

COMMERCIAL POTENTIAL: Once the miniature over-the-horizon communications module design is validated, it can be used in the production of various existing and planned miniature expendable ground based sensors and deployed by any of a large number of manned and unmanned military aircraft carrying countermeasures dispenser systems. Benefits to researchers and to research or monitoring programs are inherent in the objective of the proposed effort. Monitoring of pollutants, meteorological conditions and wildlife movements at specific ground sites in remote areas will be possible by deploying miniature sensors employing these communications modules to transmit data to remotely located users.

KEYWORDS: Miniature communications; Ground based sensors;

N03-140 TITLE: Smart Power Systems for Small, Long Term Autonomous Ground based observations

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop miniature smart power systems for long term autonomous ground based sensors.

DESCRIPTION: There is a need for the capability to place various types of ground based sensors such as biological/chemical, meteorological, audio/video surveillance, communication monitoring/decoying and vehicle/personnel movement sensors in denied areas. Using the latest technology, miniature versions of some of these sensors already exist and others are in development or are being planned. These sensors are required to be covert, small in size and to operate over periods from several weeks to several months. This will require development of sensors packaged in small form factors, greatly reducing the space available for standard battery power sources. Development of new power technology is needed for providing power to miniature unattended ground based sensors designed to operate for up to six months. These power sources, which may be combinations of technology (i.e. smart batteries, power efficient processor/controllers, solar cells, etc.), must be capable of continuously monitoring power requirements and environmental factors affecting power usage, and adjust operation accordingly.

PHASE I: Investigate new power technology appropriate for supplying long term power to miniature unattended ground sensors. Develop conceptual design of smart power module based on appropriate technology.

PHASE II: Develop and demonstrate smart power module prototypes. Develop a commercialization plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition prototype to commercial product for military/scientific use.

COMMERCIAL POTENTIAL: Once the smart power module design is validated, it can be used in production of the various existing and planned miniature expendable ground based sensors. These units can then be deployed by any of a large number of manned and unmanned military aircraft carrying countermeasures dispenser systems. Benefits to researchers and to research or monitoring programs are inherent in the objective of the proposed effort. Long term monitoring of pollutants, meteorological conditions and wildlife movements at specific ground sites in remote areas using small unattended sensor systems will be possible.

REFERENCES:

1. Frank, R., “Vehicle Integration of Electronics & Semiconductors”, Power Pulse.Net, August, 2002

2. System Management Bus (SMBus) Specification, version 2.0, August, 2000

3. Gurries, M., “Sidestepping Smart Battery System Snags”, Portable design, November, 1998

KEYWORDS: Smart power module; Expendable Sensors; Ground based sensors;

N03-141 TITLE: Precision Air Delivery (PAD) Carrier for Expendable Ground-based Sensors

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop a precision air drop carrier that can be deployed from standard military aircraft countermeasures dispensers and that can carry and accurately place various types of miniature expendable ground based sensors.

DESCRIPTION: There is a need for the capability to accurately place various types of ground based sensors such as biological/chemical, meteorological, audio/video surveillance, communication monitoring/decoying and vehicle/personnel movement sensors. Using the latest technology, miniature versions of some of these sensors already exist and others are in development or are being planned. Both deployment and operation of these sensors are generally required to be covert. Covert air delivery from high altitude, long standoff distances can be achieved by the development of a precision air drop carrier that can be deployed from standard military aircraft countermeasures dispensers and that can carry and accurately place various types of miniature expendable ground based sensors. This carrier should be wind supported during descent and employ a miniature airborne guidance unit (AGU), using GPS waypoint navigation to accurately reach its pre-programmed target. AGU, power, GPS antenna, control actuators and parachute/parafoil must be designed to require a minimum of space within a volume equivalent to an MJU-10B countermeasures flare (2” x 2.5” x 8”), allowing maximum space availability for the selected sensor module. It is assumed that selected sensor modules will be independent units containing sensor, power and data communications. All components including the sensor module compartment must be protected from the high pyrotechnic shock loading of explosive deployment from countermeasures dispensers.

PHASE I: Investigate new technology related to miniature GPS receivers, miniature power efficient actuators (Parachute/parafoil control and sensor module release/deployment). Develop conceptual design of a PAD sensor carrier based on appropriate technology.

PHASE II: Develop and demonstrate PAD sensor carrier prototypes. Develop a commercialization plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition prototype to commercial product for military/scientific use.

COMMERCIAL POTENTIAL: Once the PAD sensor carrier design is validated, production units can be built to accommodate the various existing and planned miniature expendable ground based sensors. These units can then be deployed by any of a large number of manned and unmanned military aircraft carrying countermeasures dispenser systems. Benefits to researchers and to research or monitoring programs are inherent in the objective of the proposed effort. Monitoring of pollutants, meteorological conditions and wildlife movements at specific ground sites in remote areas will be possible by deploying sensors from properly equipped NASA or NOAA manned and unmanned aircraft

REFERENCES:

1. Walker, S. H., “Precision Air Delivery Program”, Air Force Office of Scientific Research Reference Document OSR-00-04, March, 2001

2. Brown, G., Haggard, R., Almassy, R., Benney, R. and Dellicker, S., "The Affordable Guided Airdrop System" AIAA 99-1742, 15th CAES/AIAA Aerodynamic Decelerator Systems Technology Conference, June 1999.

3. "Summary Report: New World Vistas, Air and Space Power for the 21th Century," United States Air Force Science Advisory Board, 1997.

4. Final Report: Development and Demonstration of a Ram-Air Parafoil Precision Guided Airdrop System, Volume 3, Draper Laboratory under Army Contract DAAK60-94-C-0041, October 1996.

KEYWORDS: Precision Air Delivery; Expendable Sensors; Ground based sensors;

N03-142 TITLE: Bandwidth Management System

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT III PMW 179 (PM Advanced Auto Tactical Communications)

OBJECTIVE: To develop a software-based controller, the Bandwidth Management System (BMS), to allow ship’s force to operate the various bandwidth controlling hardware devices on ship. The BMS will provide a web-based user interface that abstracts the underlying traffic shaper, router, multiplexer, and caching equipment. The BMS provides a coordinated and intelligent interface for monitoring and controlling bandwidth allocation via these hardware devices. Innovative approaches are sought such that the BMS will abstract policy changes away from a variable degree of hardware complexity, thereby allowing operators to easily choose the desired balance between complexity and capability appropriate for their needs and expertise.

DESCRIPTION: Satellite bandwidth in Navy ship to shore communications is used inefficiently due to outdated static multiplexers, outdated Internet Protocol (IP) routers, and no traffic shaping or caching capabilities. In the near term, shipboard Naval communication system upgrades will include advanced dynamic multiplexers/switches, quality of service (QoS)-capable routers, IP traffic shapers, and caching devices. These devices promise great capabilities in dynamic allocation and management of precious satellite bandwidth. However, these devices represent a large increase in the level of complexity of the shipboard communication system. Furthermore, in order to achieve the efficiency goals in mind, these devices may routinely require operator attention to optimize efficiency under changing operations. When compared with the current shipboard communication equipment, which typically requires operator interaction only rarely, these new devices could represent a large and complex workload for which ship's force may not be well prepared. This solicitation seeks to alleviate and simplify this future complex tasking.

A web-based control panel, herein called the Bandwidth Management System (BMS), is desired to address this need. This web-based management system should allow for the monitoring and control of advanced dynamic multiplexers/switches, quality of service (QoS)-capable routers, IP traffic shapers, and caching devices. This management system should provide several layers of abstraction in operation of the devices. The first layer of abstraction would offer only those capabilities of device operation consistent with the simplest operation. The next layer would offer greater capabilities at the price of increased complexity, and so on. Finally the last layer of complexity would offer full capabilities of control and monitoring of the device. These layers should be designed so that an operator should be able to use the first layer with minimal training. Furthermore, the operator's use of the BMS at any given layer for a day or two should provide sufficient experience enabling him or her to proceed to use of the next layer of abstraction. The system should employ self-training assistance such as hints that pop up during mouse float-overs, electronically searchable online help, etc. The BMS should be able to save many configuration sets for the hardware so that these configurations can be recalled at a later time and reapplied to the hardware in a single step or emailed to other ships for use there. The BMS software should be designed to include a well-documented interface layer of software (or a driver) that interfaces the core BMS software to the devices under control. Therefore, if the devices under control should be changed in a future upgrade, the BMS could be made applicable to this new hardware by designing a new software driver that will interface the existing core BMS software to the new hardware.

At this writing, SPAWAR is conducting an Analysis of Alternatives (AoA) for the layer two multiplexer/switch upgrade. This AoA is expected to yield a decision regarding this layer two device before the end of calendar year 2002. Potential responders to this solicitation are encouraged to contact the primary or secondary points of contact (PPOC or SPOC) in November or December 2002 to learn which layer two device is applicable.

The quality of service (QoS)-capable router is the Cisco 3662 Router. The traffic shaping device will likely be the PacketShaper by Packeteer. This can be confirmed in autumn 2002 with the PPOC or SPOC.

On each ship, the BMS would need to be deployed in a black and red version due to security separation requirements. (The multiplexer/switch is on the encrypted (i.e. black) side of the TACLANE encryption device, while the traffic shapers, routers, and caching devices are on the clear (i.e. red) side). The black and red BMSs could be identical with different components enabled, or they could by different – but in either case, they need to have the same look, feel, and logic so as to minimize training time. Favorable innovative solutions will provide potential solutions to the RED/BLACK security issues.

PHASE I: Define Bandwidth Management System functional requirements. Research control and monitoring requirements for the caching device, traffic shaper, QoS-enabled router, and the advanced multiplexer/switch. Provide prototype software application and Graphical User Interfaces (GUI). Provide demonstration of Bandwidth Management System proof of concept.

PHASE II: Add essential functionality to Bandwidth Management System software application. Integrate monitor and control of hardware technologies and develop process to provide immediate efficiency gains in bandwidth utilization. Demonstrate these efficiency gains in an appropriately proposed verification experiment. The Navy has high regard for at sea experiments such as Fleet Battle Experiments.

PHASE III: Full scale engineering and integration of Bandwidth Management System.

COMMERCIAL POTENTIAL: Would be useful for any industry desiring to operate these devices with personnel of less expertise.

REFERENCES:

1. http://www.packeteer.com/

2. http://www.cisco.com

KEYWORDS: Internet Protocol; Connectivity, Bandwidth Management, Data Throughput

N03-143 TITLE: High Frequency (HF) Radio Automated Link Establishment (ALE)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT IV PMW 179 (PM Advanced Auto Tactical Communications)

OBJECTIVE: Develop an application that increases the number of reliable High Frequency (HF) communications links for sites with a large population of legacy HF assets and a limited number of Automatic Link Establishment (ALE) radios.

DESCRIPTION: HF Communications is still a widely used and relied upon by US Naval fleet and shore activities, as well as the other armed services and civilian agencies. HF communications is used on US Navy Amphibious ships as a primary means of communication with embarked Marines ashore. Marine troops when ashore are often capable of to twelve simultaneous HF ALE links, while the ship they are embarked on is only capable of two, or sometimes less, HF ALE links. By making HF Communications more reliable and easier to establish the Fleet could also use HF Communications for inter-battle group communications, voice and data, freeing up desirable long haul bandwidth (i.e. SATCOM) for other uses. Most, if not all Navy ships, have some form of HF radios and they continue to be procured and installed on new and existing platforms. Just recently SPAWAR PMW-179 issued a solicitation (N00039-02-R-0013) to purchase up to 17 HF Radio Group systems for the CG-47 Class, DDG-51 Class, LPD-17 Class and JCCX Class surface ships.

Currently, HF communication links are established using a manual process where operators select link frequencies using a predetermined frequency plan or using frequency prediction algorithms. This frequency selection method does not always result in the best communications link since the selected frequency is not optimized for the existing environmental conditions. As a result, operators often encounter unreliable, and in the worst case, complete loss of communications.

The Navy is currently trying to solve this problem by deploying ALE capable HF radios. These radios are capable of automatically establishing the optimal communication link by selecting the frequency that maximizes the link reliability. When ALE radios are not being used they are continuously broadcasting signals at various frequencies, which are received and recorded by other ALE capable radios. ALE radios use the link's qualitative analysis to determine the best frequency to use when establishing communication links with other ALE radios.

This technology has proved to be extremely successful. However, the large capital investment required to replace all existing legacy HF communications equipment is cost prohibitive, so new ALE capable radios are neither being deployed in a timely fashion nor in the quantity required to meet the increasing needs of Navy operators for more reliable HF communications.

To meet the increased demand for ALE communication links, an alternative software based approach is needed that would maximize the utilization of limited ALE assets. The selection of frequencies should be optimized by using ALE qualitative analysis to establish multiple links using the existing legacy non-ALE HF infrastructure.

PHASE I: Define the functional requirements for the application. Identify key technologies and communication elements that will be used for the initial implementation. Formulate an architecture and design for interface and control of the identified elements. Provide prototype Graphical User Interfaces (GUI).

PHASE II: Develop initial software application targeted to a specific HF radio suite as proof of concept. Integrate automation and control of the identified ALE and legacy HF assets.

PHASE III: Integrate & deploy into the overall naval communications architecture. Expand the software application to include additional HF equipment as well as extend the capability to multiple agencies or entities that rely on HF communications.

COMMERCIAL POTENTIAL: This capability and application would be beneficial to any services or agencies that use HF communications. During the aftermath of September 11th attacks, many agencies including rescue crews, police, firemen, State Department, FEMA, Red Cross, and others, relied on HF circuits as their primary means of communications. This capability will save time and money and allow for improved and increased communications and improve the utilization of the HF spectrum. ALE radios are available commercially and could be used in other commercial applications.

REFERENCES:

1. FEDSTD-1045A, "Telecommunications: HF Radio Automatic Link Establishment", dated October 18, 1993.

2. MIL-STD-188-141, "Interoperability and Performance Standards for Medium and High Frequency Radio Equipment".

3. High Frequency (HF) Automated Link Establishment (ALE) Transition Plan, dated April 1995.

KEYWORDS: Automatic Link Establishment (ALE); HF Communications; Management & Control; Scope; Spectrum Management; Frequency Management

N03-144 TITLE: Broadband Antenna and Radio Frequency (RF) Distribution Technologies

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I (JTRS - M/F) / PMW 179 (PM Advanced Auto Tactical Communications)

OBJECTIVE: To develop Antenna and Radio Frequency (RF) distribution techniques and technologies compatible with higher data rates, wider bandwidth, higher gain, low radar cross section, automation, dynamic power control, and scalable and integrated within the 2MHz to 2GHz spectrum, for use with the future Joint Tactical Radio System Maritime Fixed (JTRS M/F).

DESCRIPTION: Today's Naval combatants are being required to provide increased capabilities in Battle space dominance within a network centric warfare framework. The extended battle space mandates that information be shared over vast distances. Seamless information connectivity can serve as a force-multiplier, allowing rapid massing of fire power at the enemy and provide the war fighting commander with the ability to rapidly assess, and if necessary redirect, the battle. Conversely, lack of this capability slows the battle tempo, mitigates efforts to rapidly assess the battle space, and ultimately increases force vulnerability.

Current systems are limited in their capabilities to provide this battle space dominance. They cannot collect and fuse all-source tactical information from Naval, Joint, Allied, and Coalition forces. Current shipboard antennas are numerous, take up too much topside real estate, negatively contribute to radar cross section, cause blockage of other antennas, sensors and weapons, and significantly contribute to ship weight and moment. Data throughput problems, while universally problematic, are most acute on smaller platforms and to forces ashore.

New Antenna and RF distribution techniques and technologies are needed to provide these increased capabilities to the war fighter that focus on increasing data rates, bandwidth, and gain and reducing the radar cross section of surface ships.

The Navy, along with the other armed services, is moving to software capable radios, which allow the radio operation to be changed via software. For Naval ships, this dramatic increase in flexibility can only be realized if the antennas and the RF distribution system, which connects radios in the radio room to antennas on the weather decks, are also flexible. Automated or semi-automated RF switching, RF filtering, RF combining, and amplification are all of interest. RF processing, optical domain processing, or any other approaches will be considered.

PHASE I: Investigate, analyze, and develop component prototype of possible Antenna or RF distribution technologies and concepts that show promise for increasing data rates, bandwidth or gain, having low radar cross section, providing automated, dynamic power control, and being scalable and integrated within the 2MHz to 2GHz spectrum that ultimately increases information and communication capabilities to the warfighter.

PHASE II: Build and test a working prototype of the system proposed in phase I in a laboratory demonstrating confidence in technology insertion to a fully deployed Naval system.

PHASE III: Build, test, and install systems onto Naval Surface Ships for an at-sea demonstation.

COMMERCIAL POTENTIAL: The other services also have a need for improved Antenna and RF distribution technologies. Any technologies that increase capabilities in this area would be of interest to the Army, Air Force, and Coast Guard. Improved Antenna and RF distribution technologies would also be of interest to any company that provides wireless communications (i.e. cell phones, wireless networks) or to commercial shipping and aircraft companies.

REFERENCES:

1. Naval Shipboard Communications Systems, John C. Kim and Eugen I. Muehldorf, Prentice Hall, 1995

2. Network-Centric Naval Forces, Committee on Network-Centric Naval Forces, National Academy of Sciences, 2000

KEYWORDS: Antennas; Wideband; low observable, RCS; shipboard communications; network centric warfare; RF technologies

N03-145 TITLE: Adaptive TDM (Time Division Multiplexing) Resource Manager

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT IV PMW 179 (PM Advanced Auto Tactical Communications)

OBJECTIVE: The U.S, Navy seeks innovative approaches for automating TDM based naval communication requirements and simplifying the process of circuit establishment and bandwidth allocation. These approaches, referred to as the Adaptive TDM Resource Manager, should provide an operator interface that abstracts the underlying TDM equipment and equipment manager and provides a coordinated and intelligent process for automating and establishing TDM connectivity, including the ability to dynamically create and reallocate communications circuits and TDM channels. The TDM Resource Manager should allow TDM equipment to act more like Statistical Multiplexing (SM) based equipment

DESCRIPTION: The current Navy Battle Force communications and network infrastructure uses multiple limited bandwidth communication links that rely on TDM based technologies. TDM based equipment assigns and allocates channel bandwidth on a fixed and dedicated basis to multiple voice, data and video circuits. Data transmission rates are limited to INMARSAT-B circuits operating at 64 Kbps or 128 Kbps for disadvantaged small platforms and wideband SHF satellite circuits operating at 1.544 Mbps and 4.632 Mbps for an advantaged large deck platform. These speeds are limited by topside antenna space, limitations of the INMARSAT-B channels, and the cost of satellite time. Since TDM technology assigns bandwidth on a fixed basis, it does not allow the Navy to "dynamically" use bandwidth that is not being fully utilized in one or more of the established dedicated circuits that are TD multiplexed over the link. Due to the static nature of TDM, it is not easy to re-configure bandwidth that is vacant. For example, idle phone bandwidth cannot automatically be applied to data circuits. Or bandwidth reserved for a VTC cannot automatically be used by voice or data when the VTC is not being utilized. The bandwidth can be reallocated or reprioritized but it takes operator awareness to know which segment of bandwidth that is not being fully utilized and manual intervention to reprioritize and reallocate the underutilized bandwidth to a different application or circuit. Furthermore, complex coordination is required between operators at both ends of the communications link to accomplish this reallocation. There is a real need to use the idle bandwidth in the TDM links, which will have both an operational and a fiscal impact for the Navy.

Statistical Multiplexing (SM) is a technique that differs from the traditional TDM technology.

The primary difference is that TDM technologies allocate circuit bandwidth on a fixed basis, whereas SM technologies dynamically allocate bandwidth to circuits on as needed basis. This dynamic allocation allows drastic improvements in bandwidth utilization of the existing communications links.

The Adaptive TDM Resource Manager should ensure a more efficient use of the existing TDM infrastructure by providing a consistent and automated system for operators to use to manage ship to shore, or shore to shore TDM communication circuits. Currently, when a platform wants to change its existing TDM plan, it must coordinate the change with the shore site, which often requires up to 24 hours of advanced notice in order to be implemented. The Adaptive TDM Resource Manager should automate this process by providing the sailor an application that creates and prioritizes circuits as well as monitor existing TDM link usage. As the Adaptive TDM Resource Manager monitors the TDM links, it should analyze the link state as well as the circuit plan and reallocate link bandwidth as necessary. For example, when a voice circuit goes “on hook” the TDM Resource Manager should reallocate bandwidth “on the fly” to a data circuit. When the sailor initiates another voice call the TDM Resource Manager will then reallocate the bandwidth back to the voice circuit. The true measure of effectiveness for the Adaptive TDM Resource Manager will be to increase the bandwidth efficiency and utilization when compared to the existing static TDM infrastructure and allow this infrastructure to act more like SM technologies, with little to no investment in hardware upgrades.

PHASE I: Define Adaptive TDM Resource Manager functional requirements. Research TDM element control requirements, including Timeplex Link 2+, Timeplex ST-1000 and FCC-100. Provide innovative solution, including prototype software application and Graphical User Interfaces (GUI). Provide demonstration of Adaptive TDM Resource Manager proof of concept.

PHASE II: Add essential functionality to the Adaptive TDM Resource Manager software application. Integrate automation and control of TDM technologies and develop a process to provide immediate efficiency gains in bandwidth utilization. Demonstrate these efficiency gains in an appropriately proposed verification experiment. The Navy has high regard for at sea experiments such as Fleet Battle Experiments.

PHASE III: Full scale engineering and integration of the Adaptive TDM Resource Manager.

COMMERCIAL POTENTIAL: Would be useful application for automation and management of any communications circuits over limited bandwidth as well as for coordination of element management at multiple sites. Would also be beneficial for any commercial entity to maximize their use of TDM technologies. Proof of concept would encourage industry to develop other creative and innovative solutions that can enhance the overall capabilities of TDM communications infrastructures.

REFERENCES: http://www.nextirafederal.com/GSA.htm

KEYWORDS: TDM; Connectivity, Bandwidth Management, Voice Switching, Data Throughput

N03-146 TITLE: Robust Towed Array Beamforming

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT II / PMW-182 (Mobile Surveillance Systems)

OBJECTIVE: Develop algorithms for towed array shading/weighting that allow graceful performance degradation as individual phones become inoperative.

DESCRIPTION: Conventional array shading schemes, such as the Dolph-Chebyshev, improve array performance by reducing sidelobes. However, some of these schemes rely on equal spacing of phones--a condition seldom found in operational arrays due to the loss of individual phones in an otherwise functioning array. We need a towed array shading/weighting method that is optimal even in the face of inoperative phones.

PHASE I: Run simulation of the various weighted schemes. Research and define which methods are optimum for missing array elements. Determine the performance differences between current and candidate methods as a function of percentage of lost hydrophones. Propose algorithms for further exploration in Phase II.

PHASE II: Analyze data from real arrays using both conventional and proposed weighting schemes. Predict the performance degradation in terms of mainlobe width and sidelobe level as hydrophones are lost. Compare predicted performance for the conventional and proposed methods through laboratory demonstration.

PHASE III: Integrate the improved array weighting method into existing Fleet system(s). Demonstrate the improvement in towed array capability at sea in conjunction with a tactical exercise.

COMMERCIAL POTENTIAL: Underwater search and object recovery; oil exploration arrays.

REFERENCES:

1. Principles of Underwater Sound, 3rd Edition, Robert J. Urick, Mc-Graw Hill, 1983.

2. Array Signal Processing: Concepts and Techniques, Don H. Johnson and Dan E. Dugeon, PTR Prentice-Hall, 1993.

KEYWORDS: towed array, robust, hydrophones, detection, beamwidth, sidelobes

N03-147 TITLE: <u>Multi-Band Antenna For L, S, and X-Band Data</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT IV / SPAWAR PMW 155 (Meterological & Oceanographic Systems Prg Office)

OBJECTIVE: Develop a multi-band antenna for fixed surface, land portable and shipboard use capable of receiving L, S, and X band data without physical reconfiguration.

DESCRIPTION: A critical need exists throughout the maritime services for cost-effective, lightweight, multi-band antenna systems with the capability to receive L, S, and X-band signals. By using software capable of modulating between bands and frequencies, a multi-band reception system would eliminate the need to build, transport, and maintain multiple receiving dishes in the field as well as reduce topside weight and superstructure size on ships.

PHASE I: Design a multi-band antenna system. Develop a plan including performance specifications; signal processing, anti-jamming capabilities, hardware / software configuration, time and cost parameters. The end result should include timetables, test plans, and production strategies.

PHASE II: Construct and demonstrate a multi-band antenna system capable of receiving L, S and X-band signals. Provide an approach to operationally test a candidate antenna technology solution. Tests should verify that the integrated hardware and software system is capable of receiving data transmission in the three specified bands without physical reconfiguration.

PHASE III: Produce operational systems suitable for testing in both afloat and shore environments.

COMMERCIAL POTENTIAL: A multi-band receiving antenna would replace the three separate L., S, and X-band receivers currently required to receive satellite data. The L, S and X-Band antenna design could be generalized to various commercially viable multiple frequency band configurations. Multi-band antennas would possess significantly reduced operating and maintenance costs. Industry applications include environmental prediction and research, land use management and telecommunications.

REFERENCES:

1. N.S. Barker, G.M. Rebeiz, "Distributed MEMS true-time delay phase shifters and wide-band switches. IEEE Transactions on Microwave Theory and Techniques, vol.46, (no.11, pt.2), pp.1881-90, Nov. 1998.

2. C.T.-C. Nguyen, L.P.B. Katehi, G.M. Rebeiz, "Micromachined devices for wireless communications," Proceedings of the IEEE, vol.86, (no.8), pp.1756-68, Aug. 1998.

3. E.R. Brown, "RF-MEMS switches for reconfigurable integrated circuits, IEEE Transactions on Microwave Theory and Techniques, vol.46, (no.11, pt.2), pp.1868-80, Nov. 1998.

4. L. Vietzorreck, "Modeling of the Millimeter-wave Behavior of MEMS capacitive switches", IMS Symposium Digest, vol. pp. 1685-88, Anaheim, CA, June 13-19, 1999.

5. F. De Flaviis, R. Coccioli, "Combined Mechanical and Electrical Analysis of a Microelectromechanical Switch for RF Applications", European Microwave Conference, Munich, Germany, October 4-8, 1999.

6. Adrian Webster, June 4, 1998, MMA Memo 214: Hybrid arrays: the design of reconfigurable aperture-synthesis interferometers, Royal Observatory Edinburgh, Scotland, http://www.alma.nrao.edu/memos/html-memos/alma214/memo214.html

7. M. Holdaway M., 1998, MMA Configuration Design Concepts, http:/www.tuc.nrao.edu/mma/config/config.html

8. Larry E. Corey, Dec. 10-11, 2001, DARPA REConfigurable Aperture (RECAP) Program Overview, http://www.darpa.mil/spo/programs/recap.htm

KEYWORDS: Antenna Receiving System

N03-148 TITLE: <u>Development of Advanced Shape Memory Alloy Materials and Applications</u>

TECHNOLOGY AREAS: Space Platforms

ACQUISITION PROGRAM: ACAT III / SPAWAR PD-14 (Space Technology Systems)

OBJECTIVE: Develop and demonstrate improved shape memory alloy materials with significantly high strain recovery capability and with super-elasticity characteristics to enhance the reliability of release devices used in spacecraft deployment

DESCRIPTION: The use of shape memory alloys is becoming increasingly well documented along with a better understanding of their performance characteristics; however, the relatively low strain recovery capability of readily available materials (<1%) limits applications and performance. By increasing the strain recovery capability of super-elastic materials, the potential exists to increase the capacity for mechanically stored energy. This would allow for a broad range of applications such as increased reliability of mechanical dampers, ejection/deployment springs, spring loaded deployable hinges, release devices, etc., all components that are widely used in spacecraft deployment. Materials with a higher strain recovery capability do exist, but only retain this favorable characteristic at higher temperatures that do not exist in the space environment. Therefore, it is desired to enhance performance of release devices used in spacecraft by developing and producing alloys that demonstrate a significant increase in strain recovery capability (up to and greater than 10%) and with super-elasticity characteristics at ambient temperatures, either by improvement to current materials or development of new material composition.

PHASE I: Identify candidate materials, processes, and predicted performance parameters for proposed material development. Identify and evaluate applications that would be enabled and quantify the extent to which current space applications would be enhanced.

PHASE II: Demonstrate producibility of candidate materials in a laboratory environment and compare against predicted performance characteristics. Develop a prototype device identified in Phase I that could have potential use in spacecraft deployment to demonstrate improved performance.

PHASE III: Demonstrate process control over material production and supply material samples exhibiting consistent performance. Evaluate performance of materials in current and innovative applications. Define possible commercial applications and identify particular organizations and companies that might benefit.

COMMERCIAL POTENTIAL: Shape memory alloys are used in a variety of applications such as high reliability release devices and actuators on satellite systems and even dental braces. Identifying and developing materials with significantly more strain recovery capability would enhance current devices and enable new applications such as reliable deployable mechanisms, advanced mechanical dampers, etc.

REFERENCES:

1. http://www.sma-inc.com/index.html

2. http://www.smst.org/

3. http://www.sma-inc.com/References.html

KEYWORDS: Shape memory alloy, strain recovery, mechanisms, release devices, advanced metals, super-elasticity.

N03-149 TITLE: <u>Trusted Application layer interface to Trusted Operating Systems</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: SPAWAR PMW-157 (Navy Communications & Control Systems Project Office)

OBJECTIVE: The War on Terrorism has placed Coalition warfighting in the spotlight. In order to meet the informational needs of our Coalition partners, Multiple Security Levels have been implemented on shore and afloat sites. However, the implementation has resulted in multiple instantiations of applications, databases, servers, clients, etc. to serve each of the security enclaves. It is common to find three or more PC's in a single stateroom on board our ships because of the requirement for our Warfighters to maintain a "presence" in numerous enclaves.

A trusted interface layer between a trusted operating system and application layer servers allows multi-level security functionality in support of web-based and component based applications. The Trusted Application Layer Interface (TALI) is a key component to allowing client applications on multiple security levels to share server side resources, supporting reduced shipboard configurations, especially in the presence of allied / coalition forces.

DESCRIPTION: The Trusted Application Layer Interface (TALI) is a key component to enabling client applications at multiple security levels to share server side resources. The flexibility provided by TALI allows for support to Coalition operations, Homeland Security initiatives, Common Operating Picture (COP), messaging and chat for example. Also, the ability to provide trusted web-based applications residing on a small server footprint is a major step toward forward in Web-Enabling Multi-Level Security (MLS) environments in support of Task Force Web efforts. Additional flexibility is found in an abstraction layer that supports platform independence in the trusted

(OS) operating system market allowing Navy MLS applications to evolve independent of MLS technology evolution. TALI also facilitates application interoperability with other MLS systems running on different trusted Operating Systems (OS's). Developers can create applications that are not (MLS) multi-level security aware and "plug-in" to an (MLS) multi-level security environment without specialized development. This “plug-in” capability will allow existing applications to utilize the MLS functionality with minimal modifications to existing code.

PHASE I: Define preliminary requirements and prototype systems to support a feasibility study/assessment of the management and operation of security labels at the applications level. Identify documentation content required to communicate concepts and techniques. The results of this phase will be a technical feasibility study and appropriate data to support further development.

PHASE II: Iteratively Develop, test and document the prototype application layer in lab environment configured in support of the studies conducted in phase I. This phase will result in a prototype for demonstration.

PHASE III: Develop, test, and deploy final application resulting from phase II to an operational ashore or afloat environment utilizing real-world systems data. Support operational testing.

COMMERCIAL POTENTIAL: This would enable any industry requiring secure operations of their enterprise data; Financial and the Medical industry for example to execute their security plans and directives.

REFERENCES:

1. Maintaining Network Separations with Trusted Solaris™ 8 Software By Glenn Faden - Solaris Security Technology Group Sun BluePrints™ OnLine - February 2002

2. Server Virtualization with Trusted Solaris™ 8 Operating Environment By Glenn Faden - Solaris Security Technology Group Sun BluePrints™ OnLine - February 2002

KEYWORDS: Multi-layer Security; trusted Operating System; secure operating systems; security; secure

N03-150 TITLE: Multi-Intelligence SIGINT (COMINT/ELINT) Sensor Processing

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMW 189 (Naval Electronic Combat Surveillance Systems)

OBJECTIVE: Develop a foundation of algorithms that can take multi-sensor, shipboard Communications Intelligence (COMINT) and shipboard Electronic Intelligence (ELINT) system outputs and perform sensing, processing, correlation, fusion and exploitation. The foundation algorithms will be designed such that they can be built upon through a spiral development process. Spiral developments may include cross-cueing of sensors for signals analysis, contact identification, geolocation, and sensor self-focusing. These capabilities will support detailed parametric electronic signature collection that provides integrated intelligence products to the Common Operational Picture (COP)/Common Tactical Picture (CTP). A key performance parameter for these algorithms will be interoperability. The algorithms will enable automatic population of COMINT and ELINT sensor data into a common set of Extensible Markup Language (XML) tagged fields and related Document Type Definitions (DTD).

DESCRIPTION: The rapid collection and exploitation of electronic threat-emitter information is critically important to support several Navy operational missions, including Force Protection, in the littorals.

There are several EW/ELINT systems in the Navy’s inventory, some of these are: AN/WLR-1H, AN/BLQ-10, AN/WSQ-5, AN/SLQ-32(V). These EW/ELINT systems perform General Search, Priority Search, Detection, Identification, Classification, and Platform Identification of CW and Pulsed radars. The primary function of these systems is to provide Indications and Warning of potential threats. In addition, versions of AN/SLQ-32(V) are also capable of the automatic dispensing of chaff, decoys, and initiation of Electronic Attack (EA) for force protection.

There are also several COMINT systems in the Navy's inventory, some of these are: Classic Salmon, Cluster Troll, Outboard, Combat Direction Finding, Ship's Signals Exploitation Equipment (SSEE). These systems perform General Search, Priority Search, Detection, Identification, Classification, and Platform Identification of Signals of Interest. In addition, the surface Cryptologic systems (Outboard, Combat Direction Finding, SSEE) also perform geolocation. A primary function of these systems is to provide Indications and Warnings of potential threats.

In addition to these organic sources, there exist off-board sources of both COMINT and ELINT data.
Currently the EW/ELINT and COMINT data sources described above collect and process information independently without collaborative information sharing across systems either within the platform or across the battle space. In fact, these EW/ELINT and COMINT sources may be intercepting signals from the same threat platform, but since they are not interfaced with each other so there is currently no way to correlate the contact information.

The benefits of COMINT and EW/ELINT data source correlation and fusion include: Increased reaction time to Anti-Ship Missiles, a more complete picture of the battle space, and a more thorough understanding of potential threats.

The development of these new concepts and algorithms must consider the interaction of widely dispersed COMINT and EW/ELINT data sources in concert with conventional (and unconventional) weapon systems and information systems necessary for COMINT and EW/ELINT systems to operate in a network-centric battle space. The needed technologies include integration/fusion and collaborative processing algorithms, hardware connectivity and software agents that filter and tailor on and off-board sources of information for alerting and cross-cueing of sensors systems. The ability to cross-cue COMINT and EW/ELINT sensors with collaborative signals processing will enable the early identification and prosecution of threats, whether at sea or in port, and significantly reduce the risk of misidentification of enemy and friendly forces.

The technical objective is to research new concepts and develop algorithms that will enable correlation and fusion of the products of multiple ELINT and COMINT sources. These algorithms will also provide cues and alerts to the onboard and Battle Group sensor systems. at multiple security levels and to integrate that information into the Common/Tactical Operational Pictures of the Battlespace.

Research should proceed according to these three phases:

PHASE I: Research COMINT and EW/ELINT data sources. Use this information to research and design algorithms that can perform correlation and fusion of this disparate data resulting in an integrated contact report. Research alternatives, determine the requirements, and design a set of interoperable prototype algorithms that can provide this data to the network centric battle space. Research and determine a method to automatically register COMINT and ELINT XML tags and related DTD with the COMINT and ELINT Name Space in the Defense Information System Agency's XML Repository.

PHASE II: Build, test and document a DII-COE/Maritime Cryptologic Architecture (MCA) compliant, working prototype of the algorithms proposed in Phase I. The prototype software shall be tested in an operationally representative environment that utilizes multiple ELINT and multiple COMINT sensor data sources. Operational test scenarios shall be constructed that demonstrates operations in several naval mission areas. The Phase II Option should include an at-sea demonstration.

PHASE III: Integrate software developed and tested in Phase II into a Cryptologic system on surface platforms. Support operational testing.

COMMERCIAL POTENTIAL: The technology developed to support this disparate sensor correlation, fusion, and alert generation project could be used to increase our understanding of many natural phenomenons. The basic research, to develop algorithms capable of understanding and processing disparate but related data, could be used in the metrology, seismology, vulcanology, etc. These fields of study typically employ multiple sensors of different types, measuring different phenomenon that is typically correlated and integrated by hand. Cross-Cueing and alerting is also done by hand in what can be a very subjective and labor intensive process.

Other applications may include correlation and fusion of data not associated with natural phenomenon. Data such as might be collected on potential human threats could be more efficiently processed by an integrated set of correlation, fusion, alerting algorithms. This application is directly related to Homeland Security, and for integrated security surveillance systems such as, airports, borders, international shipping ports, truck depots, and prisons.

REFERENCES:

1. NWP 3-13.1.13, Information Operations Coordination

2. NWP 3-13.1.14, Naval Cryptologic Operations

3. "Implementation of Battlespace Agents for Network-centric Electronic Warfare", J. Sciortino, J. Smith, B. Kamgar-Parsi, R. Franciose, SPIE 15th AeroSense Symposium, Conference 4396, 2001.

4. Standard Generalized Markup Language, ISO 8879:1986(E)

5. Extensible Markup Language (XML) 1.0 February 1998

6. NWP 3-13.1.14, Naval Cryptologic Operations

KEYWORDS: Multi-Intelligence; ELINT; COMINT; SIGINT sensors; RF; network-centric warfare

N03-151 TITLE: Intelligent Mission Management and Tasking for the Expeditionary Sensor Grid (ESG)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMW-188 (Naval Information Warfare Activity IMPACTS program)

OBJECTIVE: Develop techniques for producing automated, high-quality conclusions and actions with associated confidence levels for a heterogeneous family of networked Naval sensors.

DESCRIPTION: The projected diversity and quantity of sensors for future networked Naval forces will create significant mission management, data assessment, and automated reasoning challenges. While the issues of sensor placement optimization and downselection of data fed from multiple sensors are already being addressed, there are no demonstrated technquies for ambiguity reduction, identity-validation, or related sensor architecture efficiency techniques. The Navy requires the application of "next generation" automated reasonsing techniques to address these problems. An evidential reasoning (ER) technique is required to derive optimal sensor architectures, real-time hybrid adaptive action selectors, and high-order conclusion makers in order to produce automated, high-quality conclusions and actions while accurately assigning confidence levels to selected actions and generated conclusions.

PHASE I: Examine evidential reasoning approaches and potential component sensors, their inputs, outputs, errors, and possible architectures of Naval sensor grids. This will provide the basis for modeling information flow, grid architecture, composite elements, actions, and conclusions to be simulated.

PHASE II: The contractor shall develop a modeling and simulation tool of potential grid architectures, information flow, and composite elements that will adequately represent the information flow and interactions as well as the warfighting enviornment. Algorithms shall be developed to account for reasoning uncertainty with respect to system actions and conclusions for the purpose of rapidly assessing the possible sensor and rule system architectures. The tool must be portable to the Global Command and Control System (GCCS) environment.

PHASE II Option: The contractor shall develop a field prototype of the mission management and tasking tool. The field prototype shall be suitable for insertion into GCCS testbed equipment.

PHASE III: Create a GCCS-M software application which provides the capability for operation on Naval ships. Additional Phase III applications include the automation of logistics asset tasking, i.e. the management of logistics platforms in a networked, distributed combat environment as naval forces place a greater emphasis on Distributed Logistics.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The software developed can be used in the management of commercial networking equipment in dealing with large data flow volumes, and can likewise be used to manage nodes found in many networked environments, to include homes and offices. In addition, it will provide for automation of commercial sensor in Building management areas (Automated detection of threats from fire/water and appropriate designation of actions to take) as well as automation of industrial complexes involving the processing of fuels and dangerous chemicals.

KEYWORDS: Sensor Architecture, Reasoning uncertainty, Information Flow,

N03-152 TITLE: Undersea (ISR) Intelligence Surveillance Reconnaissance Data Fusion Processing

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I, PMW 181- FDS program (Fixed Surveillance Systems)

OBJECTIVE: Develop innovative approaches that can fuse passive and active acoustic data from the activation of fixed sensor fields and at the field level fuse acoustic (passive and multi-static) and non-acoustic [Intelligence, Surveillance and Reconnaissance (ISR)] contacts. The desire is to use existing and future fixed sensors as multi-static receivers that can be activated by existing and future mobile and deployable acoustic sources. Fusion should take place on shore processing that uses all source data (ISR) in conjunction with undersea sensors data to support field level detection and tracking of targets.

DESCRIPTION: Numerous systems exist today that can provide event detections of both passive and active acoustic signals; and ISR sensors (SIGINT, RADINT, MASINT and IMINT) but the fusion of dissimilar sensor data into common contacts and tracks is needed. Each sensor provides unique information about the contact but without dissimilar sensor fusion the complete description of the target track (course, speed) and identification of target (surface, subsurface, merchant, combatant, class, etc.) remains unknown. Dissimilar sensor fusion is needed to de-clutter the contact space were multiple contact reports are generated for each sensor type that overlap in both time and space.

Low frequency sources such as Low Frequency Active (LFA) can activate existing fixed sensors. The next generation of fixed sensors will be able to be activated by a larger number of sources, such as, LFA, Compact Low Frequency Active (CLFA), Multi-static ASW Concept (MACE), Active Capable Expendable System (ACES) and others. Fusion of passive and active acoustic contacts has the potential of increasing contact holding time while providing both classification and localization. To take advantage of all source data processing opportunities from passive, multi-static and ISR sensors it is desired that a shore based processor be developed that can both process, detect and fuse passive and multi-static active returns from these fixed sensors.

The use of the total field of acoustic sensors and non-acoustic ISR sensors to generate field level contacts and fuse these contacts into target tracks is needed to provide the complete picture of the ocean environment.

PHASE I: Develop multi-static algorithm to detect targets that are illuminated by all available active sources; fuse passive and active detections; and fuse with dissimilar sensor (ISR) data for field level detection and tracking. Demonstrate algorithm performance through analysis and modeling of passive detection, active detection, field level detection, all source data fusion (ISR) and field level tracking.

PHASE II: Utilize real data to demonstrate that the fusion of passive, multi-static, ISR and field level algorithms perform correctly.

PHASE III: Integrate passive, multi-static, ISR and field level algorithms into the next generation of shore processing for fixed systems.

COMMERCIAL POTENTIAL: This type of multi-static processing could be used in commercial oil industry to increase the performance of ocean survey equipment. In addition multi-sensor fusion could be used in number of commercial industries to increase the performance of robotic equipment.

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KEYWORDS: Acoustic; Tracking; Multi-static; Non-acoustic; Fusion; Detection

N03-153 TITLE: Low Cost Alternatives To Expensive Complex Manifold Pipe Shapes Used In High Temperature (3000F-4500F) Missile Control Systems.

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a lower cost alternative for the existing Niobium and solid Rhenium missile divert and attitude control system.

DESCRIPTION: Current state-of-the-art technology for Strategic Missile Post Boost Control Systems is Niobium tubing formed and welded in complex shapes with built-in hot valve mechanisms. Other metals used include TZM connectors and Tantalum valve pistons. Current technologies for Tactical Missile high performance divert and attitude control systems are based on solid Rhenium with very high price tags. Efforts to develop alternate less expensive and less work intensive technologies have been undertaken. However, no lower cost alternative to the existing control system has ever been demonstrated, nor has sound technical feasibility been established. This will require additional research and development. As an example, one such promising technology, which is currently only in the feasibility phase and needs further development is dry fiber formed Carbon/Carbon material over wrap with refractory metal liners. Efforts have been currently invested to develop techniques for dry fiber material placement over complex shape elements such as tubing tees, tubing bends, toroids, conical thrusters while maintaining the ability for joining the assembly of metal liner elements and fiber elements together into a composite laminate with acceptable structural integrity. The advantage of this method is reduced strength requirements on the refractory metals and high temperature propellant oxidation resistance of the components with significant cost reductions. This example is used for illustrative purposes only and is not meant to imply that it is the preferred approach. There may be other concepts and technologies to solve this problem. Innovative approaches are required to retain high levels of performance while significantly reducing cost.

PHASE I: Identify approach to develop/produce a lower cost technology. Conduct simple preliminary cold gas hardware demonstrations and evaluate results.

PHASE II: Develop process identified in Phase I using suitable materials for operations in the 3500F-4500F temperature range. Develop and demonstrate methods of joining complex tube shapes in levels of increasing complexity. Develop stringent quality-control measures for high quality repeatable production. Conduct a suitable hot gas demonstration of developed technology and prepare a production plan for a limited number of hardware components.

PHASE III: Provide Strategic and Tactical military agencies with design guides and specifications to implement this technology in a high performance Strategic or Tactical system. Provide limited assets for Strategic Missile ground test Demonstrations and Applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This process could be applied to any weapon system requiring high temperature operation in an aggressive hot gas-oxidizing environment. Such application would be suitable for Strategic Missiles and Tactical/Strategic Interceptors. Additionally, this technology might be used for insertion of commercial launchers requiring orbit-positioning platforms, for placing commercial satellites into precise orbits and for subsequent control, in crucibles used for nuclear research, and in high temperature solar furnaces.

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KEYWORDS: Pre-forming; Carbon/Carbon; Composites; Reinforced; Controls; Refractory Metals.

N03-154 TITLE: In-Situ Propellant Monitoring System

TECHNOLOGY AREAS: Biomedical, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Strategic Systems Programs, ACAT Level I

OBJECTIVE: To develop and demonstrate an integrated sensor, analyzer, and data management device within a candidate weapon system, and a wireless, portable data collection/ reporting system (“reader”) to support life cycle assessment of the candidate weapon system. One potential approach is the use of miniaturized sensors installed within the candidate weapon system.

DESCRIPTION: The chemical stability of energetic components is one of the primary limitations of fielded ordnance systems. Programs establish conservative environmental and service life limits to ensure both performance reliability and ordnance safety. Investigations of age-related performance degradation indicate that energetic components are sensitive to environmental factors during service and storage and consequently exhibit significant variance in service life. Precise monitoring of environmental conditions and the chemical state of the degradation products of the energetic components provide the capability to significantly and safely extend ordnance component service life. Current methods for environmental condition monitoring and chemical state assessment are expensive and influence program schedules. In addition, current methods require significant system intrusion with potential safety and availability impacts and make use of scarce and high cost resources. The insertion of low cost, high reliability monitoring technology directly into produced energetic components will provide monitoring and assessment capabilities enabling potential high-payoff life extension decisions. Approaches employing miniaturized sensors have been identified as having strong potential for low cost and high reliability in-situ monitoring of chemical species and non-intrusive data acquisition. However, these sensors must be tailored to the specific constituent to be studied. To sample for several chemical compounds an array of sensors may be employed. This capability presently does not exist and therefore requires science & technology to develop a new, innovative approach.

The desired monitoring system will monitor the chemical degradation of the energetic components in two candidate weapon systems. One system is a cast double base propellant; the second is a composite-modified double base with an inert binder. For reasons of safety and cost, a small-scale demonstration vehicle that simulates the environment within the candidate weapon systems may be substituted for the actual weapon systems.

Chemical indicators of propellant degradation to be monitored include propellant stabilizers (2-nitrodiphenylamine (2NDPA) and m-nitroaniline (MNA)), stabilizer daughter products, and oxides of nitrogen. The monitoring system will collect data for these indicators of propellant degradation. Alternatively, other indicator(s) as proposed by the investigator may also be considered. This system shall provide wireless and/or passive sensors (no batteries or wires in sensors mounted or embedded within the weapon system), a portable data collection system, a data storage method and display, and a method to transmit data from the sensor to the portable data collection system (reader). After successful prototype demonstration, other sensors shall be incorporated, as available, into the system.

This effort will require both development of sensors and preprocessing devices as well as a data communication method in order to provide both real-time and off-line download of data using a remote access wireless data collection system. The system must meet all HERO and explosive safety requirements for shipboard deployment. The monitoring system shall not interfere with the normal functioning of the candidate weapon systems. The technical feasibility of simultaneously meeting all of these requirements has not yet been established and therefore involves technical risk requiring research and development.

PHASE I: Create a feasibility concept that offers the potential to monitor propellant degradation via embedded sensors in a candidate weapon system. Perform a literature survey on the maturity of miniaturized sensor technology to justify approach/concept versus utilization of similar, related technology (or alternatively to identify research and development efforts that can be leveraged for this effort). Develop requirements, design and document the in-situ monitoring system and the portable, wireless reader that will communicate with the embedded sensors. At a minimum, the system shall be able to monitor at least one chemical indicator of propellant degradation (either indicators listed above or other indicator(s) as identified by the investigator). Propose a demonstration vehicle or vehicles to simulate the candidate weapon systems, to be utilized in the evaluation of the sensors in Phases II and III.

PHASE II: Based on the feasibility concept of Phase I, fabricate a prototype device for the in-situ monitoring of the candidate weapon system. Conduct a demonstration of the prototype to define performance capabilities.

PHASE III: Integrate the sensors into the demonstration vehicle. Demonstrate the ability of this system to collect data for the identified chemical species. Demonstrate the ability of the portable, wireless reader to collect data from the embedded sensors. The expected transition would be to the Strategic Systems Programs in the areas of the Trident Launcher system and the missile solid rocket motor/gas generator subsystems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system has significant applicability to commercial/government systems for active monitoring of stored chemical compounds, particularly energetics, which may not be easily or inexpensively accessible. Potential for monitoring production, storage and transportation of hazardous materials including nuclear waste.

REFERENCES: "Microsystems Abound", Sandia Technology, Spring 1999

KEYWORDS: in-situ monitoring; miniaturized sensors; double base propellant; condition-based maintenance; chemical decomposition

N03-155 TITLE: Low-cost Multi-sensors as Embedded Gauges for In-situ Non-Destructive Evaluation (NDE) of Rocket Motor Serviceability

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Strategic Systems Program

OBJECTIVE: To develop low-cost, multi-sensors, such as Micro-Electro-Mechanical-Systems (MEMS), capable of measuring/monitoring temperature, humidity, acceleration, as well as changes in mechanical properties within the rocket motor. The intent is to use data from these sensors to evaluate the serviceability of the weapon system. A couple of technical challenges exist; one is to develop sensor systems compatible with both existing ordnance systems as well as new systems and the second challenge is to combine available sensor technologies into a multi-sensor capable of communicating without physical connection and maintaining a size which is compatible for incorporation into the various components of the missile system.

DESCRIPTION: Currently, the service life of various solid rocket motor systems are assessed and/or extended by conducting a surveillance/type-life program, which is costly and time-consuming. These programs typically address the life of a weapon system in terms of the entire weapons population. They don't account for the potential of having motors that may have service lives outside of this population due to variations during manufacturing, environmental excursions during shipping and storage or deployment conditions. By utilizing sensors built into or around the motor, the serviceability or "fitness for duty" of an individual motor would be determined based on a detailed "risk assessment" of embedded sensor data. This would avoid the use of motors with either a safety hazard or reduced performance, and enable the analyst to perform a "risk assessment" on individual systems. The idea is to insure we are able to get the full service life out of an individual weapon by querying the data and making a "fitness for duty" determination before deployment. As one might expect, this approach is equally applicable to both strategic and tactical systems, to warheads as well as rocket motors and to ingredients/parts monitoring prior to manufacture.

There are a number of sensor technologies capable of measuring the desired parameters. The R&D Risks within this topic are developing sensor systems which can be both retrofitted into existing systems as well as being compatible with new systems which have severe volume and weight constraints; in addition, the combination of the different sensors into a single multi-sensor capable of external communication without physical connection.

PHASE I: Perform a feasibility study to determine the best available sensor technology for incorporation into a multi-sensor for rocket motor serviceability monitoring. Because of the R&D risks associated with these technologies, this topic will initially focus on environmental and mechanical properties sensing systems.

PHASE II: Develop a composite multi-sensor capable of measuring/monitoring temperature, humidity, acceleration and mechanical properties (stress/strain), with the capability for growth to incorporate other sensors (such as chemical systems) as they become available. This system should be able to transmit data without physical connection to a data acquisition system and must be compatible with use in composite and rubber systems.

PHASE III: Multi-sensors will be provided to Strategic Systems Program for incorporation into existing Trident systems as well as prototype motors. Trident's existing aging motor assets will be used to evaluate the robustness of the delivered sensor systems to normal storage and handling conditions. The prototype motors will be exposed to environmental testing and the sensors queried for component response to these tests. The SBIR recipient will produce sensors and their participation will be required throughout the Phase III of the program. Measurements from both aging and prototype motors will be compared to surveillance data to determine accuracy of data gathered from sensor devices. The final transition of the technology will be into Strategic Systems Programs and it would provide "fitness for duty" assessments for the solid rocket motor, gas generator and post-boost control systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Multi-sensor technology has a large potential payoff in the manufacturing industry in the development of a conditioned-based maintenance system that could be capable of significantly reducing operating costs. Just as manufacturers have gone to "Just In Time" deliveries from their suppliers to reduce manufacturing costs, incorporation of such sensors could revolutionize maintenance so that there were no production losses due to broken equipment nor would maintenance be done on a conservative schedule. A simple example would be the use mechanical properties sensors on the pick-up hook for an overhead crane system that provides a warning when the part has developed microscopic stress fractures. These fractures when undetected could result in failure under load. Currently hooks are required to undergo costly X-ray and die penetrant testing to look for these fractures. An even larger payoff would be for deep-water oil wells where cross currents put casings under extreme lateral loads. Should these loads result in stress fractures causing failure of the casing, many millions of dollars in crude oil could be lost coupled with millions in environmental cleanup. In-situ stress monitoring would allow a shutdown or repair of the system prior to failure. This sensor technology is particularly applicable to non-accessible or expensive-to-reach systems and provides a method to manage production needs and maintenance costs in a resource (budget, manpower, facilities) constrained environment.

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KEYWORDS: Rocket Motors; Surveillance; Service Life Extension (SLE); Sensors; Micro-Electro-Mechanical-Systems (MEMS); Non-destructive Evaluation (NDE)