**NAVY**
**SBIR FY04.3 PROPOSAL SUBMISSION**

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper, (703) 696-8528. The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **1 July 2004.** 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 (NEW Phase I and Phase I Option Amounts for NAVAIR topics only!)**

Read the DoD Program Solicitation at www.dodsbir.net/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 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 section 4.0 of the program solicitation. 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

For topics N04-183 thru N04-230 the base effort should not exceed $70,000 and 6 months with an option not exceeding $30,000 and 3 months. For NAVAIR topics N04-231 through N04-265, the base amount should not exceed $80,000 and 6 months with an option not exceeding $70,000 and 6 months. **PROPOSALS THAT HAVE A HIGHER DOLLAR AMOUNT THAN ALLOWED FOR THAT TOPIC WILL BE CONSIDERED NON-RESPONSIVE**.

All proposal submissions to the Navy SBIR Program must be submitted electronically. It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR Submission website at **http://www.dodsbir.net/submission**. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST).

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 **6:00 a.m. EST, 12 August 2004** deadline. A hardcopy will NOT be required. A signature by hand or electronically is not required at the time of submission.

*Acceptable Formats for Online Submission:* All technical proposal files will be converted to 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, proposal number and topic number as a page header in your technical proposal document. Cost sheets can be included in the technical proposal or submitted separately through the Cost Proposal form available through the Submission website. Technical Proposals should conform to the limitations on margins and number of pages specified in the DoD Program Solicitation. However, your on-line Cost Proposal form will only count as one page and your Cover Sheets will only count as two, no matter how they print out after being converted. 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 your file before you upload. If a virus is detected, the file will be deleted. To verify that your proposal has been received, click on the "Check Upload" icon to view your proposal. Typically, your proposal will be virus checked and converted 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 contract. 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 section 4.5 of this solicitation.

**PHASE II PROPOSAL SUBMISSION (NEW Phase II and Phase II Option Amounts!)**

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which achieved success in Phase I, as determined by the Navy Activity point of contact (POC) measuring the results achieved against the criteria contained in section 4.3, will be 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 the Phase I effort awardees will be notified to participate for evaluation of their proposal for a Phase II award. Evaluation criteria for the invitation will be based on the success to which the company has accomplished for the particular topic as evaluated by the monitoring activity/command. 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 the program 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.

Since the inflation rate over the past twelve years approximates 33%, at the discretion of the Navy Activity, the Navy has increased the amount of phase II funding offered up to $1 million. Specific guidelines on the new base and option amounts will be explained in your invitation letter from the requesting activity. 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 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 visit the website cited in the invitation letter to get specific guidance for that Navy Activity 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). 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 is submitted separately through the website. Your proposal must be submitted via the submission site on or before the Navy Activity specified deadline.

All Phase II award winners must attend a one-day Transition Assistance Program (TAP) 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.dawnbreaker.com/navytap. It is recommended to budget at least one trip to Washington in your Phase II cost proposal.

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 benefits. It should require minimal work from the contractor because most of this information is required in the final report.

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 II ENHANCEMENT**

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.

**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 government's 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 | Email |
|---|---|---|---|
| N04-183 thru N04-198 | Mr. James Johnson | MARCOR | johnsonje@mcsc.usmc.mil |
| N04-199 thru N04-223 | Ms. Janet Jaensch | NAVSEA | JaenschJL@navsea.navy.mil |
| N04-224 | Mr. Jack Speaker | NAVSUP | john.j.speaker@navy.mil |
| N04-225 thru N04-227 | Ms. Cathy Nodgaard | ONR | nodgaac@onr.navy.mil |
| N04-228 thru N04-230 | Mr. Charles Marino | SSP | charles.marino@ssp.navy.mil |
| N04-231 thru N04-265 | Mrs. Carol Van Wyk | NAVAIR | carol.vanwyk@navy.mil |

**For general program and administrative questions, please contact the Program Managers above; do not** contact them for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 03 May 2004 through 30 June 2004. These topic authors are listed on the Navy website under "Solicitation" or the DoD website. Beginning 1 July, you must use the SITIS system listed in section 1.5c of the program solicitation to receive answers to technical questions.

**PHASE I PROPOSAL SUBMISSION CHECKLIST:**

**All of the following criteria <u>must be met</u> or your proposal will be REJECTED.**

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

**____2. Your technical proposal has been uploaded and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 12 August 2004.**

**____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. For topics N04-183 – N04-230, the Phase I proposed cost for the base effort does not exceed $70,000 and 6months and for the option $30,000 and 3 months. For NAVAIR topics N04-231 thru N04-265, the base effort does not exceed $80,000 and 6 months and the option does not exceed $70,000 and 6 months . 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 04.3 Topic Index


N04-183 Nanotechnology Fabric Innovation
N04-184 Development of Optimal Light Weight Personnel Armor Systems
N04-185 Liner Material for CB Protective Garment
N04-186 Expeditionary Meteorological Capability for Fire Support
N04-187 Target Location Technology for Ground Based Observers
N04-188 High Mobility Removable Camouflage System
N04-189 Improved Sealed Enclosure
N04-190 Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development
N04-191 Suspension and Track Noise and Vibration Reduction for Marine Corps Advanced Amphibious Assault Vehicle (EFV)
N04-192 Development of enhanced active damping system for the Marine Corps Expeditionary Fighting Vehicle (EFV)
N04-193 Integrated Trailer, Generator, Environmental Control Unit (ECU)
N04-194 Ultra Lightweight Battery Charger/Generator
N04-195 Human Fatigue Modeling
N04-196 Public Key Certificate Acceptance Technology
N04-197 'Smart Dust' and Nanotechnology for Joint Weapons Systems Diagnostics/Prognostics
N04-198 Persistent Illuminators as a Replacement for Tritium in Weapons Sights
N04-199 Automated Weapons Assembly
N04-200 Lightweight Fire Insulation
N04-201 Small, Cost Effective Mine Location Marker
N04-202 JTRS Compliant Antenna for 21" Unmanned Undersea Vehicles
N04-203 UAV-based mine detection using a short pulse, high repetition rate, multicolor laser transmitter
N04-204 Pressure Tolerant Power Source for Off-Board Sensor
N04-205 Underwater Acoustic Positioning System
N04-206 Multi-Vehicle Mission Planner for Unmanned Vehicles
N04-207 Multi aspect sonar classification for High Resolution Broadband Sonar (HRBS)
~~N04-208 Acoustic Surveillance Multi-Array Search Aid~~ CANCELLED
N04-209 Solid-state LIDAR Chip
N04-210 Avoidance of Twinline Towed Array Entanglement
N04-211 Heat and Humidity Cumulative Exposure Sensor
N04-212 Technology for Advanced Ship Designs
N04-213 Advanced Structural Development for Cargo Stowage Systems
N04-214 Comprehensive Spectrum Management for Wireless Networks
N04-215 Sensor Synchronization Technologies
N04-216 Power generation for weight and space limited USV systems
N04-217 Multi-function Connectors for Shipboard Equipment
N04-218 Algorithms for Rapid and Accurate Depth Localization of Targets for Mine Avoidance
N04-219 Object Avoidance for Unmanned Surface Vehicles (USVs)
N04-220 Embedded Pressure Sensors for Automation and Control of Fluid Valves
N04-221 Acoustic, Thermal and Fire Insulation System
N04-222 Active Noise Reduction Technology
N04-223 Total Ship Computing Environment Infrastructure (TSCE-I) Hardware and Software Technology
N04-224 Elimination of Wood Dunnage in Trucks, Railcars, ISO Containers and Combat Logistics Force (CLF) Ship Cargo Holds
N04-225 Stable Platform Module for Ships
N04-226 Large Format Monolithic CCD Camera
N04-227 Integration and Optimization of Hydrogen Production with Ocean Thermal Energy Conversion Technology in Offshore Floating Platforms
N04-228 Development of a Sensor System for Reliable, Automated Detection of Surfaced Swimmers
N04-229 Secure Communications in a Noisy Environment
N04-230 Data Fusion for Geophysical Aided Navigation Technologies
N04-231 Display and Visualization of Movement Predictions for Ground Vehicles
N04-232 Altitude, Latitude, and Longitude Reference Database of Man-Made Obstacles
N04-233 Object/Target Discrimination, Recognition, and Identification

| | |
|---|---|
| N04-234 | Hypersonic Infrared Dome |
| N04-235 | Portable Handheld Imaging Radar System Technology |
| N04-236 | Enhanced Data Link Performance in Multipath and Interference Environments |
| N04-237 | Mobile Shallow Water Antisubmarine Warfare (ASW) Target System |
| N04-238 | Cosite Interference Reduction for Electronic Attack Aircraft |
| N04-239 | Advanced Ram Air Driven Power and Cooling Unit |
| N04-240 | Advanced Nonskid Coating System for Mobile Airfield Landing Mats |
| N04-241 | Detecting Target Maneuvers with the Radar Range Rate Measurement |
| N04-242 | Rugged, Low-Cost, Nondielectric Missile Radome |
| N04-243 | Multi-Level Secure High-Speed Shared Memory Interconnect |
| N04-244 | Field Programmable Gate Array (FPGA) Processor Firmware Development Modularization Methodology |
| N04-245 | Light Detection and Ranging (LIDAR) Surface Feature Extraction Tool |
| N04-246 | Management of Imagery Data in Simulation Training Systems Via Content Based Retrieval and Indexing |
| N04-247 | Littoral Environment Parameter Estimation from Bistatic and Multistatic Fleet Air Antisubmarine Warfare (ASW) Acoustic Reverberation Data |
| N04-248 | Low Cost Three-Dimensional Reinforced Ceramic Matrix Composites (CMCs) |
| N04-249 | Innovative Quality Control Assessment Methods for Ceramic Matrix Composite (CMC) Components |
| N04-250 | Environmental Resistance for Ceramic Matrix Composites (CMCs) |
| N04-251 | High-Temperature Sizing Development |
| N04-252 | High-Temperature Adhesive Development |
| N04-253 | Threat Spectrum Direction Finding Unit |
| N04-254 | Low-Cost Fiber-Optic Connector Cleaner |
| N04-255 | Maintainer Head and Hearing Protection |
| N04-256 | Wireless Sensors with Advanced Detection and Prognostic Capabilities for Corrosion Health Management |
| N04-257 | Enhanced Rotorcraft Aerodynamic Modules to Support Flight Testing |
| N04-258 | Advanced Fault and Failure Anomaly Detection Technologies to Support Enhanced Prognostics and Health Monitoring (PHM) Capabilities |
| N04-259 | Ni-Cad Battery State-of-Health Indication Improvements |
| N04-260 | Embedded Wiring Diagnostic Technology for Aircraft |
| N04-261 | Erosion Resistant Coatings for Shaft-Driven Compressor (SDC) Impellers |
| N04-262 | Automated Nondestructive Evaluation (NDE) System for Finding Foreign Materials and Contaminants in Manually Fabricated Composite Components |
| N04-263 | Advanced Multi-Band Electronic Surveillance Measure (ESM) Antenna |
| N04-264 | Automated Software Architecture Analysis and Visualization Advanced of Large, Mixed-Language Systems |
| N04-265 | Miniature GPS Antenna System |

## Navy 04.3 Topic Descriptions

N04-183 TITLE: Nanotechnology Fabric Innovation

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PM Infantry Combat Equipment (ICE)

OBJECTIVE: The objective is to develop uniforms and individual combat clothing items utilizing nanotechnology, which changes and improves textile molecular structure in order to create improved performance fabrics.

DESCRIPTION: Nanotechnology could potentially be applied to fabrics in order to improve the performance and function of clothing items. Primary steps in the development process are to create garments using nanotechnology, which will change the molecular structure of the current fabrics being used to enhance the fabric's physical properties to create improved performance fabric. Nanotechnology manipulates the proprietary structure of fabric to create unique variations of desirable properties on fabric. The use of this technology gives the fabric advanced performance characteristics and does not distort the hand, breathe ability or durability of the original fabric. The use of nanotechnology in combat clothing and uniforms would allow for various fabrication combinations that are not typically available to non-treated fabrics. Nanotechnology usage in fabric manipulation would allow uniforms to have wrinkle-free properties, dry wicking properties, and superior water resistance all in one fabric, and in non-conventional fabrics. A polyester wool blended uniform blouse that today cannot retain these properties at the same time can with the use of nanotechnology.

PHASE I: Develop concepts for a uniform (garrison) blouse that will have wrinkle-free, water resistant, and dry wicking properties, that do not distort the current aesthetic appearance or hand of current fabric. Evaluate the process of the concept to troubleshoot all areas of improvement. Determine product capabilities, in garrison uniform situations to test durability, comfort and fit. Conduct an analysis of these concepts that considers manufacturing cost, life cycle cost, logistics considerations performance and physical property testing. Demonstrate concept feasibility for the introduction of this new technology to other uniform items. Based on the information developed by the end of the Phase I, make recommendations for a uniform blouse that can be demonstrated in Phase II.

PHASE II: Select a final concept from Phase I and develop prototypes. Conduct laboratory testing to evaluate physical properties. Conduct field evaluation of prototype and do product analysis. . The Marine Corps will conduct the field evaluation and provide feedback to the contractor. Results from the Phase II development and field evaluation will be analyzed and documented.

PHASE III: Manufacture the garment for the military, and the commercial apparel industry. Develop a marketing plan to introduce this technology to other facets of combat clothing, and equipment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial apparel industry does have a growing interest in textiles and garments that utilize nanotechnology. Currently many major menswear manufacturers are using this technology to develop wrinkle free cotton dress shirts, and breathe able all weather suiting. However, with the possibilities in production so viable with the military, the reality of the commercial apparel industry to get more involved will increase. Commercial applications include, men's apparel and women's apparel.

REFERENCES:

1. Nano-tex: http:// nano-tex.com
2. Wonderfully Wrinkle Free: The Wrinkle resistant cotton phenomenon: www.touchofcotton.cm/wrinklefree/hompage.cfm?pageID=122&sectionID1
3. Mark Ganem Delta Sky "If Brooks could Kill: BrooksCool from Brooks Brothers is no oxymoron" pg24-25.


KEYWORDS: nanotechnology, combat uniform, and clothing

N04-184 TITLE: Development of Optimal Light Weight Personnel Armor Systems

TECHNOLOGY AREAS: Materials/Processes, Human Systems

ACQUISITION PROGRAM: ACAT IV: PM Infantry Combat Equipment

OBJECTIVE: The primary goals of this effort are: (1) to develop optimal lightweight personnel armor for Soft – Fabric systems for protection against fragmentation type munitions and multi-hit handgun bullet protection, (2) to develop optimal lightweight personnel armor components to be used in conjunction with ceramic or suitable alternative armor for defeat of small arms projectiles and (3) to develop a system consisting of goals (1) and (2) that reduces blunt trauma injuries incurred through deformation of the back face of the armor component.

DESCRIPTION: The United States Marine Corps (USMC) has an on-going need for improved body protection against ballistic and fragmentation threat. The current Soft – Fabric system employed by the USMC, the Outer Tactical Vest (OTV), weights 7.5 pounds in a medium size and has pockets to accept hard, fiber-reinforced ceramic components known as Small Arms Protective Insert (SAPI) plates to provide additional protection for the front and back areas of the marine.

To date no research and development program has adequately addressed the optimization of the OTV and SAPI plates as a system. Specifically, the Marine Corps has a pressing requirement for innovative research and development of an improved OTV/SAPI plate system. This topic seeks to satisfy this requirement through the research and development of new materials for both the soft-fabric OTV and the SAPI plate inserts, to characterize the interactions between individual system components, and to optimize the overall system performance through the design of new combinations, material configurations, and/or individual components. The ultimate goal of this effort is to maintain or increase the fragmentation and ballistic protection of the respective Soft – Fabric and SAPI system while dramatically decreasing the weight of the items both independently and as a coherent structure.

Any proposed system must, as a minimum, satisfy existing material performance, coverage, and weight characteristics. A sample of existing component performance requirements follow.

The OTV must provided protection against the following threats:

Fragmentation (V50 in ft/sec)

| | 0 Degree Obliquity | 45 Degree Obliquity |
|---|---|---|
| 2 grain | 2725 | 2925 |
| 17 grain | 1925 | 1950 |
| 207 grain | 1400 | 1450 |

Handgun (9mm 124 grain FMJ Remington)
V50 0 Degree Obliquity: 1625 ft/sec
V0 0 & 30 Degree Obliquity: 1500 +50/-0 ft/sec
Maximum Back face Deformation: 1.73 in

The SAPI plates, when tested in conjunction with soft body armor, must provide protection against the following threats:

Projectiles (V50 fps, 0 degree obliquity)
NATO 7.62 x 51mm M-80 Ball 2,850
Soviet 7.62mm x 54R Ball Type LPS 2,400
U.S. 5.56mm M855 Ball 3,300

Projectiles (V0 fps, 3 impacts, 2 at 0 degree and 1 at 30 degree obliquity)
NATO 7.62 x 51mm M-80 Ball 2,750 + 50 fps
Soviet 7.62mm x 54R Ball Type LPS 2,300 + 50 fps
U.S. 5.56mm M855 Ball 3,250 + 50 fps

The Back face deformation must not exceed1.70 inches when measured to the lowest point of indentation. And finally, the maximum weight objective is 5.5 pounds for the OTV (Size Medium), 2.5 pounds for the each SAPI plate (combined weight of 5.0 pounds) and a combined system weight not to exceed 10.5 pounds.

PHASE I: Identify alternative candidate technologies to evaluate. Develop candidate design concepts to evaluate the feasibility of satisfying system requirements. Model and evaluate the relative strengths and weaknesses of each technology to include parameters such as size, weight, reliability/durability, fragmentation protection, safety and associated health hazards. Conduct a trade off analysis of these concepts that considers manufacturing cost, life cycle cost, logistic considerations and performance. Based on the information developed by the end of the Phase I, recommend a prototype system(s) that can be demonstrated in Phase II.

PHASE II: Based on alternatives evaluated in Phase I produce a prototype(s) for developmental testing. Contractor(s) will have the applicable references to conduct appropriate fragmentation and ballistics developmental testing. Developmental ballistics testing will be performed on each item independently as well as testing of the OTV/SAPI configuration as a system. Developmental testing shall include tests for ballistics, fragmentation and back face deformation. A final candidate(s) will be selected for continuation into Phase III.

PHASE III: The United States Marine Corps will conduct the final field evaluations on form and fit of the final candidate selected during Phase III. Testing will include laboratory testing of physical properties, ballistics testing and human factors/wear testing by Marines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Enormous private sector and commercial potential for an effective, reduced weight  protection system. Potential markets are likely to include police entities, emergency response agencies, and all law enforcement agencies around the United States. In addition, the possibility of expanding into the commercial sporting industry has the potential to even further lower the production cost of the end item.

REFERENCES:
1. DeLuca, E., Prifti, J., “Terminal Ballistic Simulation of Munition Fragments” AMMRC TR-32, Watertown, MA December 1974

2. Mackiewicz, J., et. Al., “Ballistic Test and Analysis Methodology for Acceptance of Personnel Fragmentation Armor”, U.S. Army Soldier Systems Center, Natick, MA (To Be Published)

3. Mackiewicz, J., and G. Proulx, “Effect of Fiber-Reinforced Plastic Strength Properties on the Ballistic Performance of Ceramic Comate Armor”, Natick TR-99/006, U.S. Army Soldier Systems Command, Natick, MA.

4. DeLuca, E., Prifti, J., “Ballistic Impact Damage of S-2 Glass Reinforced Plastic Structural Armor” Composites Science and Technology (1998) 1453-1461, Published by Elsewier Science Ltd. (Great Britian).

5. CO/PD 002A Purchase Description Body Armor, Multiple Threat / Interceptor

6. CO/PD 00-03 Small Arms Protective Inserts (SAPI)

KEYWORDS: Ballistics, Fragmentation,

N04-185 TITLE: Liner Material for CB Protective Garment

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Marine Corps Systems Command PM Marine/NBC

OBJECTIVE: Develop a chemical/biological (CB) protective liner material for individual protective suits that is compatible with a shell material and provides NBC protection equivalent to or better than the current JSLIST garment.

Improved performance is desired in areas including, but not limited to: heat stress, durability, overall CB protection after salt-water immersion, and overall CB protection.

DESCRIPTION: The current JSLIST garment does not meet all requirements as outlined in the JSLIST Operational Requirements Document (ORD). Increased performance in several areas could remove restrictions currently limiting usage. The liner offers an area for enhancement. The liner material could demonstrate its benefit in many areas including enhanced CB protection after salt-water immersion, improved durability (greater than 720 wear hours), flame resistance, and reduced heat stress. For example, reducing heat stress would increase the minutes of work per hour in the recommended work/rest cycle.

PHASE I: Develop and demonstrate a prototype CB protective liner material as validated by the testing procedures outlined in Test Operating Procedures (TOP) 8-2-501.

PHASE II: Required Phase II deliverables will be a liner material, that when integrated with shell material, will demonstrate equivalent or improved performance characteristics when compared to the JSLIST. Test methods will vary as necessary to evaluate expected performance benefits.

PHASE III: Transition to an appropriate Acquisition or Additional Source Qualification program for the JSLIST liner material. Commercial applications would be immediate.

PRIVATE SECTOR COMMERCIAL POTENTIAL: DoD will purchase a minimum of 4 million additional CB protective garments from FY 04 through FY 12. In addition, private sector application will be sales to the domestic preparedness market (i.e. Department of Homeland Security, State and local fire, police, EMS, hospitals).

REFERENCES:
1. Joint Service Lightweight Integrated Suit Technology Operational Requirements Document and TOP 8-2-501, Permeation and Penetration Testing of Air-Permeable, Semipermeable, and Impermeable Materials with Chemical Agents or Simulants (Swatch Testing) found at:
https://www.quickplace.marcorsyscom.usmc.mil/QuickPlace/jslist_additional_source_qualification/Main.nsf/h_Toc/4df38292d748069d0525670800167212/?OpenDocument

KEYWORDS: Biological; Chemical; Individual; JSLIST; Heat Stress; Liner

N04-186 TITLE: Expeditionary Meteorological Capability for Fire Support

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PM Fire Support Systems; Program: Meteorological Measuring Set Profiler

OBJECTIVE: Development of portable technologies to determine localized winds and pressures aloft and in potential target areas to increase the accuracy of fire support systems.

DESCRIPTION: Future fire support systems will be required to operate in a dynamic environment characterized by rapid movements of both the battery and the supported units. In addition, the ranges over which accurate fire support must be available will increase. One of the major factors affecting the accurate delivery of gunnery fire support is determination of the wind profile through which the rounds will travel. Current systems typically involve tracking the profile of a balloon. This technique is prone to large errors and compromises the location of the Meteorological (MET) station. In many cases, the MET station is located a significant distance from the battery, and the wind profiles generated may not apply at the battery location due to intervening terrain features. Furthermore, units that utilize submunition dispensing ordnance must have a clear understanding of the wind conditions in the target area to maximize effect on target and minimize colatteral damage.

PHASE I: Study, design and propose technologies that will enable the determination of localized winds and pressures aloft. The technologies proposed must be relatively compact, have low-power requirements, and be simple to use. Software-based concepts must be capable of operating on computers typically used in the tactical environment.

PHASE II: Develop any necessary software and/or hardware necessary to demonstrate the performance of the technology. Conduct testing to confirm the theoretical accuracies determined in Phase I.

PHASE III: The technology will be hardened and integrated into appropriate Marine Corps hardware for operational experimentation. The results of the experimentation will shape the integration of the technology into the Marine Corps fire support team.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private airports, remote weather measurement stations, fire-fighting teams and boats could use Ruggedized MET stations for weather/wind predictions.

REFERENCES:
1. Joint Model Project for Battlescale Atmospheric Conditions: http://www.evac.ou.edu/jmpbac/intro.html

2. White Sands Test Center Capabilities webpage:
http://wstc.wsmr.army.mil/capabilities/range_supp/meteor/artmetcomaidartmetpro.html

KEYWORDS: Meteorology; Fire Support; Artillery; Radar; Sensors; Fusion; Algorithm; Software

N04-187 TITLE: Target Location Technology for Ground Based Observers

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PM Fire Support Systems; Program: Common Laser Rangefinder (CLRF)

OBJECTIVE: Development of technology for ground-based observer teams to determine coordinates of targets at ranges greater than five kilometers with Target Location Errors (TLEs) less than ten meters.

DESCRIPTION: Current and future fire support systems are becoming more accurate due to advances in GPS guidance and IMU technologies. However, the inherent accuracy of these munitions makes them more sensitive to errors in the target coordinates, frequently referred to as Target Location Error (TLE). For the Marine Corps, the most common source of target coordinate data is the ground-based observer. These observers are foot-mobile and may operate in austere environments for extended periods of time. Combat load constraints limit the amouint of equipment available for targeting. Currently these observers rely upon GPS, laser rangefinders, and an azimuth-measuring device to determine coordinates. Errors due to azimuth-sensing devices such as compasses increase linearly with range, so at extended ranges their contribution to TLE is significant. Since it is desirable to maximize the standoff range between the observer and the target, a new technology or technique to determine target coordinates from a remote location is sought.

PHASE I: Propose technologies that will enable ground-based observers to calculate the coordinates of a target greater than five kilometers away. The proposed technical approach should include the error sources from all components of the system, with a combined Target Location Error (TLE) of less than ten meters. Solutions involving Unmanned Aerial Vehicles (UAVs) must be derived from a class of UAVs appropriate for tasking from a ground-based observer. A feasibility analysis of the technology and the risks associated with its implementation will be developed.

PHASE II: Develop any necessary hardware and/or software necessary to demonstrate the performance of the technology. Conduct testing to confirm the theoretical accuracies determined in Phase I.

PHASE III: The technology will be hardened and integrated into appropriate Maine Corps hardware for operational experimentation. The results of the experimentation will shape the integration of the technology into the ground-based Marine Corps fire support team.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be used in a wide variety of commercial surveying activities, particularly in remote, inaccessible regions.

REFERENCES:
1. USAF INTELLIGENCE TARGETING GUIDE: http://www.fas.org/irp/doddir/usaf/afpam14-210/part13.htm

KEYWORDS: Targeting; UAV; Image Processing; GPS; Stabilization; Ortho-rectification

N04-188 TITLE: High Mobility Removable Camouflage System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: EFV

OBJECTIVE: This project seeks to develop a high mobility camouflage system that consists of camouflage removable material covering the turret and weapon station, roof and upper glacis of the EFV.

DESCRIPTION: The Marine Corps EFV (formerly the Advanced Amphibious Assault Vehicle (AAAV)) is a 76,000 lb armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. In addition to the signature management inherent to the design of the EFV, a camouflage screening system is required to maintain vehicle and crew survivability. The objective of this solicitation is to develop new and advanced signature management system technologies necessary to satisfy the operational signature reduction requirements for the USMC's only ACAT I ground vehicle program. Our research and test development over the past few years has determined that there is no viable solution available that can meet the environmental, logistical, and signature performance demands of the EFV. We require a system that not only performs equally well in the visual, near-infrared, infrared, and radar spectrums, but a system that is ultra-light, ultra-durable, low cost and semi-permanently applied to the vehicle as opposed to a netting solution. This highly mobile camouflage system must withstand the environmental demands of salt water immersion, continuous abuse by operators and natural obstacles such as trees and brush, and subjection to excessive forces such as when the main gun fires and causes existing materials to melt or be blown away. Current technology is fragile, bulky, heavy and unmanageable. It must be removed every time the vehicle is redeployed. The space and weight allocated on the EFV for a full spectrum signature reduction system is extremely limited due to other competing engineering and operational challenges. The current LCSS (Lightweight Camouflage Screening System) or proposed ULCANS (Ultra Lightweight Camouflage Net System) as proposed for the EFV requires significant volume and weight allocations for on-board stowage (22 cu ft, 226#). The current EFV configuration does not have the available stowage volume or weight allocation for the entire ULCANS. This project seeks to develop a high mobility camouflage system that consists of camouflage removable material covering the turret and weapon station, roof and upper glacis of the EFV. This will be combined with camouflage net material, similar to the above, that can extend from the upper perimeter of the vehicle to the ground 360 degrees around the vehicle. It is intended that this net material will be stowed on-board the vehicle without negative impact to EFV performance requirements including, but not limited to, signature management, weapon station, mobility, communication, personnel egress, and safety. The system shall overcome durability and signature performance issues that currently exist with available camouflage removable materials. The systems shall provide screening performance in the visual, near-infrared, infrared, and radar spectrums. It is expected that multiple systems will be required to provide screening in desert, woodland, winter and arctic environments. Successful designs shall attempt to minimize weight with a goal to not exceed the weight of the ULCANS without poles. However, highly survivable or minimal cost innovative designs exceeding current system weights will be considered on an overall value basis to the EFV program.

PHASE I: Identify potential technology/direction for camouflage system development. Evaluate identified solutions and methodologies. Develop the 'best value' technology and solution.

PHASE II: Integrate thermal signature treatments with the mobile camouflage system. Initial testing requirements would include panel testing and material maturation testing. Several different versions of material could be developed with varying spectral characteristics. These are then evaluated in a developmental testing environment along with laboratory testing of material performance testing (e.g. durability, flammability, etc.). Analysis of this test data will lead to an iterative design process of material maturation.

PHASE III: Develop full rate manufacturing plans and implement on the EFV. Subsequent developmental testing will consist of complete kit integration on the target platform and evaluation conducted in an operational environment with appropriate visual and thermal sensors providing data for analysis. Also, concurrent and additional testing would evaluate compatibility with a tracked vehicle operational environment. Additionally, user involvement would also provide data on the interaction of human factors and system performance. This final demonstration on the platform will provide the desired signature management performance and prove out deployment and functionality concepts. At the completion of the demonstration, the camouflage kit will be ready for limited fabrication of production-representative systems in order to support a major operational assessment of the host platform by the user.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This application is directly applicable to all vehicles that require camouflage treatment. Once developed and demonstrated, this camouflage concept will have tremendous applicability, primarily to the Marine Corps and Army ground combat vehicle platforms (tanks, AAV's, and LAV's) but also to any Service's camouflaged platform. All would be able to immediately benefit from the improved signature performance provided by such kits.

REFERENCES:
1. Advanced Amphibious Assault Website – www.EFV.usmc.mil

KEYWORDS: durability; signature; camouflage; applique; materials

N04-189 TITLE: Improved Sealed Enclosure

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: EFV

OBJECTIVE: To Develop an Improved sealed Enclosure and Cooling System for Commercial Grade Electronics Subassemblies.

DESCRIPTION: The Marine Corps EFV (formerly the Advanced Amphibious Assault Vehicle(AAAV) is a 76,000 LB armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. It contains Command and Control and vehicle control electronic systems. These commercial grade circuit cards in these systems need to be protected from the harsh environmental conditions the vehicle will be operating in. The present state-of-the-art sealed enclosure technology is an open loop vapor/fluid system inside of the sealed enclosure. Detailed examination of this type of system reveals that the enclosure is mostly responsible for the ability to house a commercial grade (0 to 55 degrees C) Circuit Card Assembly (CCA) in order to operate in a (-40 to 60 degree C) ambient environment. The enclosure itself is responsible for limiting the internal ambient temperature to 70 degrees C or below which supports the majority of components on a commercial grade CCA. The enclosure also provides additional thermal margin for the energy input necessary for spot cooling of power supply modules, bus switching modules, and commercial processors on the CCAs. These components' normal operating temperature with a heat sink is limited to 55 degrees C at 6 cubic feet per meter airflow (CFM). In the present state of the art, the open loop vapor/fluid system is used to control temperature in only the areas requiring the spot cooling. The above understanding leads one to consider alternative methods of spot cooling within a better enclosure while maintaining the 10 degree C increase from external ambient (70 degrees C internal max at 60 degrees C external ambient Max).

Although the technology described above is not fielded and is in its infancy, a more innovative solution is needed for EFV, preferably prior to Full Rate Production (FRP). Improvement to the enclosure itself will allow for slightly less efficient cooling alternatives to be incorporated into an innovative system without the open fluid system limitations. These current limitations are directly related to fluid collection inside of a sealed enclosure that is running an open loop system. Depending upon the orientation of the enclosure, fluid can be in one or more of the eight corners at any given time. Furthermore, for level orientations fluid will collect in four of eight corners simultaneously which lowers the level significantly more at a collection point than if the fluid was in a single corner (non-level orientation). Yet another limitation is the effect of oscillating movement (sloshing) where fluid is only present in the corners for a small portion of time (the rest of the time the fluid is travelling between corners). If the oscillation is close to the reaction time of the valves at the corners, a situation can occur where the fluid moves away before the system can react. It is difficult to predict all the enclosure orientations needed to successfully perform in any given operating environment. The problem complexity increases when one considers marine and airborne applications due to oscillating movement and/or wider ranges of orientation.

PHASE I: Perform engineering analysis, preliminary design, identify test facilities for design verification, and provide schedule for prototype builds to meet test facility availability. The proposed technology shall demonstrate air temperature inside the enclosure less that 70 degrees C while maintaining temperature within design limits for processors, switching modules, power supply modules, etc. This shall be accomplished with a continuous ambient temperature outside of the enclosure of 60 degrees C. The proposed technology shall be capable of sustaining cooling at 60 C ambient conditions in any physical orientation continuously throughout the service life of the enclosure. The proposed technology shall be capable of retrofit into the EFV, and shall provide performances comparable to the present state-of-the-art in the following areas.

Space-claim: Height = 13.6" Width = 15.0" Depth = 13.2"
Weight: 70 lbs. (5 lbs. additional for external fan cooling)
Efficiency: Based on cooling method and enclosure design, efficiency may need to be higher than the state-of-the-art. Methods for thermally forcing heat from the chassis, such as solid state cooling, should not increase overall power consumption of the enclosure by more than 20 %.
Submersion: The system shall be sealed and capable of submersion to 3 meters

Materials: All external materials shall be NBC compliant and the enclosure shall be designed as to not trap biological matter when pressure washed.

PHASE II: Develop and build prototype units for testing that will include commercial grade (0-70C) processors types of RISC, Pentium, and SPARC operating VxWorks, Windows NT Server, and Solaris Operating Systems as well as benchmarking software sufficient to generate appropriate processor heat loading. Design and develop final prototypes for on-vehicle testing in an Expeditionary Fighting Vehicle (EFV) platform.

PHASE III: Develop full rate manufacturing plans and implement.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A robust Orientation Independent Enclosure and cooling method can allow state-of the art C4I solutions to be directly inserted into other Air Force/Navy/Army/Marine Corps environments. In particular, highly maneuverable (fighter, attack) aircraft, communications / control / weapons platforms susceptible to dust and grit and vehicles exposed to seawater would benefit from the temperature and contamination protection. With the ability to take a common hardware set into all military environments, a Common Tactical Picture can be achieved easily. Furthermore, the military software applications involved will only need to be upgraded for a single scaleable architecture making bulk buys between tech refresh cycles, and software planning for system upgrades more manageable in the future. The ability to use commercial grade CCAs developed for the Telecommunications Industry represents the maximum affordability for multi-service C4I systems in allowing the military to join a large commercial customer base and the ability to incorporate system upgrades. All the above potential usage is one for one with commercial equipment that is exposed to rugged terrain and harsh operating conditions.

REFERENCES:
1. Advanced Amphibious Assault Website – www.EFV.usmc.mil

KEYWORDS: Commercial Grade Circuit Card Assembly (COTS CCA); advanced cooling; electronics, dry chassis

N04-190 TITLE: Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: EFV

OBJECTIVE: Conduct research in self-sealing fuel tank technology and the development of an integrated material solution that is low cost, rugged, lightweight, and non-flammable; which will enable vehicle operation in hostile environments and minimize loss of fuel due to a direct / indirect hit.

DESCRIPTION: The Marine Corps Expeditionary Fighting Vehicle (EFV) is a 76,000 pound armored vehicle designed to operate over harsh off-road terrain and in oceans and rivers. The EFV is expected to operate in severe environments such as high humidity, seawater, sand, mud, rocks, gravel, etc. and must be capable of withstanding severe impact and abrasion loads from rock and debris while moving at high speed (45 mph) over rough cross country terrain. Climatic conditions can range from –65□F to +125□F and the EFVs Primary Fuel is JP8; and its Alternate Fuels are DF-1, DF-2, DF-A, JP5 and DFM.

Current self-sealing fuel tank technology has reached a critical point. With the current technology, self-sealing fuel tanks can only seal against small arms. Beyond that point, the technology breaks down, and is unable to perform. There is no system/material/technology out there that seals to the level the EFV requires. EFV needs the performance of the self-sealing fuel tanks to be equivalent to the EFV current armor protection level.

Commercially available (COTS) Self-Sealing Fuel Tank coatings have been explored and incorporated into the EFV external fuel tanks. The EFV program would like to improve on the survivability and increase the capability of the self sealing fuel tank. This effort seeks an integrated solution that goes beyond current COTS. The solution may include design of an innovative self-sealing fuel tank or a new material to coat the existing tanks, which would meet the requirements. Since the vehicle design is maturing, Low-Rate Initial Production scheduled for November 2005, changes to the existing vehicle structure become increasingly difficult. The Small Business must plan their research and design to integrate into the existing baseline (fuel tank space claim and interfaces).

The technology and/or material solution must be designed to self-seal against the direct and indirect fire threats stated as threshold protection in the EFV Operational Requirements Document (ORD). Yaw and obliquity must also be taken into effect, when determining the capability of the technology to self-seal. It must also minimize the follow-through of fuel into the vehicle interior due to an overmatch threat hit on the external fuel tank system.

Any materials and processes recommended must comply with environmental regulations and requirements, and must avoid EFV Program mandated hazardous materials. Class I or Class II Ozone Depleting Substances (ODS) and the EPA List of 17 Chemicals are prohibited.

To reduce Total Ownership Cost (TOC) is not the focus of this SBIR. However, the proposals can address TOC as a secondary consideration by focussing on the unit production cost and also at logistics costs during the Operations and Maintenance phase of the EFV program, by reducing maintenance time and increasing reliability and availability.

PHASE I: Identify self-sealing technologies that meet the protection requirement for the EFV program. The research should principally focus on identification of new technologies and the application of those technologies that could be readily transferable to land, mobile and amphibious military operations. The research should also recommend materials, process, and design improvements, relative to existing COTS/MOTS self-sealing fuel tank technologies. Aspects such as manufacturing methods, non-recurring engineering cost, and maintainability requirements need to be addressed.

PHASE II: Design, develop, produce, and conduct limited developmental testing using the EFV system platform and associated subsystems to validate the feasibility of the technology to be potentially fielded.

PHASE III: Transition technology into EFV for Low Rate Initial Production. Also, apply this technology to the automotive and other military service arenas.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied in many defense programs (domestic and international), other Government Agency programs and commercial applications including armored vehicles and industrial vehicles/machines, operating in harsh environments.

REFERENCES:

1. Expeditionary Fighting Vehicle Website ¡V www.efv.usmc.mil

2. MIL-T-5578C(5) TANK, FUEL, AIRCRAFT, SELF-SEALING

3. MIL-DTL-5624T TURBINE FUEL, AVIATION, GRADES JP-4, JP-5, AND JP-5/JP-8 ST

4. MIL-DTL-83133E TURBINE FUELS, AVIATION, KEROSENE TYPES, NATO F-34(JP-8), NATO F-35, AND JP-8 + 100

KEYWORDS: Fuel Tank; Self-Sealing; Materials Engineering; Ballistics; Lightweight

N04-191 TITLE: Suspension and Track Noise and Vibration Reduction for Marine Corps Advanced Amphibious Assault Vehicle (EFV)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: EFV

OBJECTIVE: Develop a lightweight, low vibration and low noise Track and Suspension solution for heavier armored vehicle suspension systems such as on the Marine Corps Expeditionary Fighting Vehicle (EFV).

DESCRIPTION: The Marine Corps is looking to significantly reduce armored vehicle suspension system noise and vibration by developing new and innovative low-vibration and low noise Suspension and Track technology to attenuate noise/vibration transmission into the vehicle’s onboard equipment and personnel. Currently, no suitable low-vibration alternative track system exists for the EFV (Expeditionary Fighting Vehicle) or any other heavy armored vehicle. This alternative track system will improve ride quality (crew comfort), survivability, and reduce equipment and structural damage resulting from excessive vibration. Also, excessive vibration reduces the amount of vehicle ride time that troops can safely tolerate at one time before suffering ill health effects such as nausea and disorientation. The Marine Corps EFV program considers solving this problem one of its highest priorities but has been only marginally successful to date. Past testing by both the Marine Corps and Army has confirmed that, on armored vehicles, the suspension and track system is the primary source of vibration and one of the most significant noise sources. This includes track, idler wheels, roadwheels, support rollers, and the carriers. Recent testing has proven conclusively that if track and suspension system vibration is significantly reduced, crew comfort and ride quality will improve dramatically. Also, modern armored vehicles are incorporating ever-increasing quantities of electronic hardware that is subject to damage by continuous or excessive vehicle vibration. Currently, all modern heavy armored vehicles (including the EFV) use double-pin track because of its superior durability on high weight class vehicles. The drawback is that double-pin track is a source of high vibration and noise. One example of an alternative low-vibration suspension system concept is that of single pin track. Recent test data has proven conclusively that single pin track induces substantially less overall vibration and noise into the vehicle and has the potential to reduce overall track weight due to being comprised of a smaller number of steel components. New technology may exist that has the potential to extend the life of single pin (or other alternative track) allowing it to be used in place of the heavier, noisier, high vibration double pin track. This is also true for the M1 Abrams Tank, the M88 Retriever, and many foreign manufactured armored vehicles. The technology developed for the EFV Suspension system could also be used to improve the durability of lighter vehicle track systems resulting in significant life cycle cost savings. Serious consideration will be given to all suspension system concepts that have the potential to reduce vibration and noise levels while achieving adequate durability. With improved ride quality, overall EFV combat effectiveness and mobility will be enhanced. If successful, a new standard of performance will be set for armored vehicle suspension and track systems. The technologies proposed must be cost effective, lightweight, and durable. This solution must be independent of any dampening system.

PHASE I: Develop alternative low vibration, low noise suspension track system concept that is durable and cost effective. Key criteria will be cost, weight, durability, and vibration reduction.

PHASE II: Develop detailed designs and field prototype hardware for lab testing and EFV on-vehicle testing. Redesign to improve reliability and optimize to maximize reduction of vibration and noise. Produce and field test improved hardware. Provide test support, failure analysis, and redesign support.

PHASE III: Support fabrication and procurement for EFV. Provide test support, redesign support, and perform failure analysis during durability and whole body vibration testing.

Private Sector Commercial Potential: Can be used where noise reduction or isolation is needed for both on and off road vehicles as well as equipment. This technology can especially benefit heavy vehicle and equipment needs where loads are relatively high and excessive heat build-up can degrade component life.

REFERENCES:

1. Advanced Amphibious Assault Website – www.efv.usmc.mil

2. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22

3. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189

KEYWORDS: Noise, vibration, ride quality

N04-192 TITLE: Development of enhanced active damping system for the Marine Corps Expeditionary Fighting Vehicle (EFV)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: EFV

DESCRIPTION: The Marine Corps' Expeditionary Fighting Vehicle (EFV), formerly the Advanced Amphibious Assault Vehicle, is a 76,000 lb. armored vehicle designed to operate in oceans and rivers and over harsh off-road terrain at speeds exceeding 40 mph. The Marine Corps is looking to significantly improve off-road vehicle ride quality and cross-country mobility for heavy, off-road vehicles such as the EFV. This need has arisen because current suspension technology is still unable to meet the more stringent requirements necessary for improved troop comfort, combat effectiveness, and personnel/equipment survivability.

The most capable current state-of-the-art suspension system that could potentially be adapted for heavy, off-road vehicles is the Active Damping suspension system. A less capable semi-active system, currently used on an EFV prototype, has not provided the level of performance desired.. Although Active Damping suspension technologies appears to hold the greatest potential to address this critical need, no research to date has developed a suspension system competent to satisfy the requirements of heavier armored vehicles such as the 76,000 lb EFV.

This SBIR topic proposes the research, development, and demonstration of a fully active damping system suitable for use on heavy armored vehicles. Despite the apparent promise of the fully active damping technology it is recognized that the technological risks associated with this approach are significant. Therefore, it is emphasized that the research efforts are directed toward the development of a fully active damping system able to satisfy the requirements of heavy, off-road vehicles such as the EFV, not simply to develop fully active damping technology for moderate weight vehicles. It is also emphasized that although the EFV shall be used as the prototype model it is envisioned that this technology shall eventually be incorporated into other vehicle programs such as the Army's Future Combat Systems (FCS) and the Marine Corps Tank Systems.

PHASE I: Identify critical ride quality performance characteristics for heavy, off-road vehicles using the EFV to model such vehicles. Develop a preliminary design concept for a fully active damping control system, determine the feasibility of such system, and perform modeling/testing of alternative designs to optimize system performance. Specifically, design a fully active damping suspension system that offers the potential to significantly improve performance, does not increase vehicle weight, seeks to minimize design impact to existing components, and is cost effective.

PHASE II: Build a prototype fully active damping system based on the developmental work performed during phase I. Perform developmental testing using the prototype(s) in order to investigate system performance parameters in relation to system design characteristics. Using the information gained through the developmental testing improve the system design in order to optimize the system benefits.

PHASE III: Following design stabilization in Phase II perform system testing and evaluation to characterize system performance. Once sufficient data is collected to determine if system reliability, performance characteristics and manufacturability satisfy objectives incorporate these improvements into the EFV production vehicle design.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Fully active damping control technology will potentially benefit commercial systems already using forms of active damping control. For example, improvements can be incorporated into automobile, heavy truck applications, off road construction (earth movers, etc.) equipment, heavy mining vehicles, and some types of manufacturing equipment where damping control will improve process stability. Share this technology with FCS and Tank Systems programs to provide improved performance for these vehicles.

REFERENCES:
1. Advanced Amphibious Assault Website – www.efv.usmc.mil

2. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22

3. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189

KEYWORDS: Shock, vibration, ride quality

N04-193 TITLE: Integrated Trailer, Generator, Environmental Control Unit (ECU)

TECHNOLOGY AREAS: Chemical/Bio Defense, Ground/Sea Vehicles, Materials/Processes, Electronics, Battlespace

ACQUISITION PROGRAM: PM Expeditionary Power Systems, PM UOC and PM NBC Defense Systems.

OBJECTIVE: To develop and demonstrate an integrated system that can be towed off-road behind a HMMWV (less than 4200 pounds), provide 100,000 BTU of cooling, 10 kW (15 kW desired) of 120 VAC power above what is needed for the Environmental Control Unit (ECU), carry enough fuel for 24 hours of operation and carry an additional 500 to 1000 pounds of cargo.

DESCRIPTION: The Marines need a system that can be towed behind a HMMWV, provides power and cooling and has a cargo caring capacity. Current developed systems cannot meet the requirements stated in the objective. The main limiting factor on the current designs is the oversized generators that are used to handle the in-rush current from starting the compressor on the ECU. In steady state, the system could function with a 20 kW generator, but current designs use 30 to 40 kW generators to handle the in-rush condition. The use of these oversized generators greatly reduces the cargo carrying capacity, reduces fuel efficiency and leads to wet stacking problems. Through this SBIR, we would like to explore innovative ways to optimize the design to maximize cargo carrying capacity.

PHASE I: Investigate ways to meet the requirements stated above. Consider innovative design concepts like an integrated Generator/ECU to improve efficiency, reduce weight and maximize cargo carrying capacity. Consider the use direct drive compressors for the ECU, Hybrid Electric designs to handle pulse power requirements, absorption cycle cooling to take advantage of the waste heat from the generator and variable frequency compressors to avoid spikes. Look at advanced suspension and load-balancing designs to maximize speed on rough roads and off-road. Consider the use of composite materials and high strength aluminum or titanium to reduce trailer weight. Conduct a whole system trade study to determine the best technical approach to meeting the requirements in a cost effective way. Present a design concept at the final review and document the study in a technical report. All applicable roadway, environmental, and emission standards must be met.

PHASE II: Using results from Phase I, the contractor shall build a working prototype system and test it in accordance with a government approved test plan. If testing a subsystem can prove out their design concept, an integrated

Generator/ECU or a Lightweight Trailer for example, the contractor is encouraged to focus on this area. The test will include durability, fuel consumption, noise level, power quality and environmental testing. The contractor will make modifications as needed to successfully complete the test requirements. A final prototypes or reconditioned/modified prototype will be delivered to the government after the contractor testing for field evaluation. A final design review will be held to discuss test results and transition opportunities.

PHASE III: The contractor will prepare a manufacturing plan and marketing plan to sell his product to the government as well as the private sector. The contractor will make the necessary teaming arrangements with the manufacturers of the components used in this product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied anywhere there is a requirement for mobile power and cooling. Some examples include circus tents, county fairs/craft shows and disaster relief situations.

KEYWORDS: Integrated Power/Cooling, Mobile Systems and Trailers

N04-194 TITLE: Ultra Lightweight Battery Charger/Generator

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

ACQUISITION PROGRAM: PM Expeditionary Power Systems, PM Intelligence Systems, PM NBC Defense Sys

OBJECTIVE: To develop and demonstrate an ultra lightweight battery charger/generator for reconnaissance missions and remote sensors.

DESCRIPTION: The recent interest in Unmanned Aerial Vehicles (UAV) by the military has accelerated research on small, lightweight JP8 burning, internal combustion engines. There are now small engines available that work on JP8 fuel, at reasonable prices that could be used for other applications to include ultra lightweight generators and battery chargers. This program will leverage the work completed by the UAV industry and develop a lightweight battery charger/electrical generator for varied ground combat Marine Corps applications.

The Ultra Lightweight Battery Charger/Generator shall produce a minimum of 500 Watts (1000 Watts desired), single phase, 60 Hz AC in a package that is less than 15 pounds (10 pounds desired), excluding fuel. The system shall operate from a remote fuel container but will have the capability to pump fuel from that container. The system shall produce no more than 75 dB at 7 meters required (70dB at 7 meters desired). The system shall have a minimum 600-hour life before major components need to be replaced.

PHASE I: Design a system to meet the requirements stated above. Conduct market research and trade studies to balance design factors such as cost, fuel efficiency, reliability, component life and weight. Conduct analysis to predict system performance for at least 2 alternatives. Make recommendations for a Phase II detailed design and document in a technical report.

PHASE II: Using results from Phase I, the contractor shall build at least 2 working prototype systems. The contractor shall develop a laboratory test plan to address, at a minimum: engine performance across temperature, dust, and altitude extremes; power output for regulation, quality, stability and transient response; durability testing of components and full system; and physical performance criteria for size, weight, noise, smoke, and fuel efficiency. Upon Government approval of the test plan, it shall be executed and results reported. The contractor shall make modifications as needed to successfully complete the test requirements. The contractor shall document and provide a Safety Assessment Report of the systems. At least 2 final prototypes or reconditioned/modified prototypes shall be delivered to the government after the contractor testing. These units will be used by the Government in field evaluations and the contractor shall support the evaluation with spare parts and technical advice. A final design review will be held to discuss test results and transition opportunities.

PHASE III: The contractor shall prepare a manufacturing plan and marketing plan to sell his product to the government as well as the private sector. The contractor will make the necessary teaming arrangements with the manufacturers of the components used in this product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied in any work environment where there is a requirement for portable power and energy systems. Any battery-powered system that must operate in a remote location for an extended length of time would benefit from this project.

KEYWORDS: UAV Engines, Lightweight Power, Portable Power, Battery Recharge

N04-195 TITLE: Human Fatigue Modeling

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PM-MERS, Marine Expeditionary Rifle Squad

OBJECTIVE: Develop and demonstrate modeling and simulation tools to track the cognitive and physiological performance degradation of dismounted Infantry over time as a result of fatigue. These tools will be utilized in Computer Generated Force (CGF) simulations for small unit operations involving Marine Rifle Squads.

DESCRIPTION: There are no COTS or GOTS modeling and simulation tool sets that support interoperable simulations where human performance is considered in relationship to the fatigue induced by various equipment, tactics, time, etc. Members of the Marine Rifle Squad work long periods of time under stress and sleep deprivation while conducting manual labor and having to maintaining mental alertness. They often carry excessive combat loads, including ammunition, rations, water, weapon and additional combat gear while traveling cross-country on foot in adverse terrain. A model of the human performance, stressors and effects that adequately represents the warfighter's contribution to mission performance is needed.

Currently there are software models for assessing the combat worth of systems and sub-systems for small units of warfighters in high-resolution combat operations, for estimating the energy expenditure for materials handling tasks, and for evaluation of human performance in controlled environments. The software often models tasks of short duration or allow a high level of continuous performance until the individual is no longer functional. A software model is needed that reflects the performance of the warfighters as it varies over time based on changing levels of fatigue, stress and exhaustion. This modeling and simulation software would be used in conjunction with other software models to perform the analytical evaluation of variations in the items worn, carried and consumed by the Marine Rifle Squad as they shoot, move and communicate.

While advances have been made in the modeling and simulation of tactical systems and computer-generated forces (CGF), these advances typically have seen the greatest strides in relating system physics to environmental properties, and visual realism. However, the complexities of human physiology pose a significant challenge to modeling the individual warfighter’s response to long durations (4 hours to 3 days) of activity, stress, and injury. In addition, the warfighter's performance will vary over time based on changing levels of fatigue, stress and exhaustion. Valid representations of the effects of physiological stressors, such as fatigue, with respect to individual entities in CGFs is key to simulating small unit tactical behaviors, analysis of variants in equipment specification, and valid force-on-force simulations.

From the standpoint of systems acquisition, human systems integration (HSI) is often regarded as an afterthought to systems performance specifications. Initiatives, such as those being undertaken by the Marine Expeditionary Rifle Squad Program Manager, seek to establish an analytical relationship between equipment properties, equipment usage and human performance to optimize the human-system (or human-equipment) performance. These initiatives need to be supported with suitable modeling and simulation tools that address the variations of human performance levels caused by various fatigue factors.

PHASE I: Define the factors contributing to fatigue in the battlefield and relate them to key human performance parameters. Identify a formalism for specifying fatigue / performance characteristics and establish a modeling approach to relate those characteristics to equipment or system specifications. Design a modeling and simulation tool set to support interoperable simulations where human performance is to be considered in relation to the fatigue induced by various equipment, tactics, time, etc.

PHASE II: Develop a prototype of the tool-set described in Phase I. Demonstrate the use of this tool set in a computer generated forces simulation, gathering simulation statistics that can be used to validate the models performance. Identify various DoD and commercial applications that would benefit from this research.

PHASE III: Produce and market the final tool-set.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be applied in any market sector that involves modeling human fatigue, such as developing sports gear and exercise equipment.

REFERENCES:
1. Booher, Harold R. (2003). Handbook of Human Systems Integration. A Wiley-Interscience publication.; University of Michigan, College of Engineering, Center for Ergonomics Energy Expenditure Prediction Program (www.engin.umich.edu/dept/ioe/ENGEXP/)

KEYWORDS: Automation; Fatigue; Workload; Human factors; Human Performance in System Models; Human Modeling and Simulation; Computer Generated Forces (CGF)

N04-196 TITLE: Public Key Certificate Acceptance Technology

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Investigate various usage scenarios of potential standards for server-based certificate acceptance processing.

DESCRIPTION: In order to meet the United States (U.S.) Department of Defense (DoD) Public Key Infrastructure (PKI) policy and to ensure the security of the applications, many of the U.S. Navy and Marine Corps applications must be public key enabled. Some of these applications will benefit from the emerging server-based certificate validation technology called Simple Certificate Validation Protocol (SCVP). The Internet Engineering Task Force (IETF) is in the process of defining the standard for SCVP. Vendors are beginning to develop and offer beta products in this area. The primary motivations for server-based certificate validation approach are “thin” clients, centralized control over the PKI and enhanced security of certification path validation. The SCVP standard will only cover the communication protocol between the server and client. The protocol and associated X.509 standard will imply what security-related checks and processing the server must perform and what security-related processing the client must perform. However, the standard will not specify the techniques in the area of certification path development, an operation that requires significant computer and communication resources. The purpose of this research is to develop and demonstrate efficient techniques for server-based certification path development. Very little research has been done in terms path development efficiency. In a server-based environment issues such as, caching, handling of partial certification paths, depth first vs. breadth first construction and forward vs. reverse construction may play an important role. This effort will encompass the following: analysis of the alternatives for server based path development algorithms; design of a modular path development algorithm which can be configured for the various modes to explore the efficiency gains; development of the test data to test the efficiency of path development algorithms.

PHASE I: The contractor shall investigate server-based path development alternatives and path development efficiency in general and shall design a modular and efficient path development algorithm. The contractor will create or identify a test bed containing several PKI architectures.

PHASE II: The contractor shall develop a reference implementation of the algorithm and conduct empirical studies regarding path development efficiency using the test beds from Phase I. The contractor shall document the findings and make recommendations.

PHASE III: The research findings and reference implementation shall be made available to the SCVP and Public Key Enablement toolkit vendors for inclusion in their product offerings.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The research will help improve the quality of PKI-related products, especially in the area of certification path processing efficiency.

REFERENCES:
1. Simple Certificate Validation Protocol (SCVP), Malpani, Housley, and Freeman, Internet Draft RFC, October 2003.

2. Certification Path Development, Cooper et. al., Internet Draft RFC, October 2003.

KEYWORDS: PKI; SCVP; certification path processing;

N04-197 TITLE: 'Smart Dust' and Nanotechnology for Joint Weapons Systems Diagnostics/Prognostics

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

ACQUISITION PROGRAM: Program Management Test, Measurement and Diagnostic Equipment (PMTMDE)

OBJECTIVE: Develop highly integrated, ultra-miniature, non-obtrusive, wireless, sensory systems for greatly enhanced weapons systems diagnostics to the Light Armored Vehicle (LAV). These micro-miniature technologies would aid greatly in the collection of on-system weapons systems information for diagnostics and prognostics purposes. This will tie into current Joint Service efforts such as GCSS/GCCS and Autonomic Logistics by providing unparalleled visibility into the status and maintenance condition of a specific weapons system platform.

DESCRIPTION: Maintainers lack visibility into their equipment beyond any built in test or embedded diagnostics capability that the weapon system might possess.

Recent advances in microelectrical-mechanical systems(MEMS) and nanotechnology should allow the integration of a class of devices small enough to be rapidly placed on legacy equipment with minimal/no visible alterations to the equipment itself.

When maintenance is performed, having ultraminiturized sensor capability within the system would provide precise knowledge of the system condition and allow dramatically increased diagnostics capability, with rapid pinpointing of the system's problem. Therefore, accuracy, speed of diagnosis, and unprecedented visibility into weapons systems behavior and possible incipient failure would be aided by this type of technology.

This effort would combine the latest in state-of-the-art micro- and nano-system device and integration technologies into an autonomous smart micro/nanosensor device for application to diagnostics/prognostics monitoring of legacy DoD ground based vehicles and telecommunications equipment.

The resulting devices will explore a variety of current/emerging micro and nano sensor technologies. They will employ sensor fusion capability, include networkability through common standards such as the IEEE 1451 standard, provide extremely low power and short range wireless capability (using multiple technologies based on need and environment, i.e. RF, infrared, UWB, et.), and make use of emerging power scavenging techniques for extended lifetime. This system could potentially be adaptable to any weapon system or equipment within the DoD.

PHASE I: Develop a prototype for the smart dust sensor type for the LAV and a separate processing node device capable of interfacing with potentially hundreds or thousands of smart dust sensors. For the purpose of this initial effort, the design shall be capable of accommodation of up to 50 sensors. This design will include the overall device architecture concept and implementation, and communication protocols. The initial sensorial focus will be on current, voltage, and temperature sensing. The prototype will also consider the range of emerging power scavenging and sourcing technologies to help dramatically extend operational lifetimes.(i.e. vibration, heat, sound, voltage, isotopic, current power scavenging). Consideration of a larger common data processing node device to be able to collate the information from the 'net' of sensors. Environmental constraints posed by the mix of climates and conditions (mud, oil, sand, moisture et.) encountered worldwide to these sensors will be explored and the methods considered to provide mitigation. Standardized systems engineering concepts for this technology will be proposed that stabilize sensor placement methodologies and other considerations.

PHASE II: Using prototype sensors and processing node prototype, network test a autonomous smart dust technology for diagnostics on a specific DoD system (such as LAV or Avenger or other systems). This phase will also include selection of a candidate DoD system for initial tests of prototypes, and the documenting of the diagnostic requirements of that system. The prototype smart dust devices will employ multiple sensors, and will be integrated into the LAV system for tests. Using economies of scale technologies such as employed by the semiconductor industry, consideration will be given to create a set of adaptable technologies that will drive eventual costs to be a dollar or less per wireless, multi-capable sensor. Size consideration goal is for a complete sensor class each smaller than an aspirin. The processing node technology will be capable of communication to a maintainer or via emerging maintenance shared data environments such as GCSS.

PHASE III: Design and employ a series of smart dust systems providing diagnostics/prognostics technologies of unprecedented penetration and low cost for commercial, DoD and Federal Government applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Devices of the type developed in this effort would find wide-spread application in commercial activities involving fleets of in-service equipment such as the airline and shipping industries, as well as any systems requiring remote sensing.

REFERENCES:
1. 'Smart dust protocols for local detection and propagation' ACM Workshop On Principles Of Mobile Computing, Proceedings of the second ACM international workshop on Principles of mobile computing
Toulouse, France, Pages: 9 - 16, Year of Publication: 2002
ISBN:1-58113-511-4

2. 'Intelligent Sensor Validation and Fusion with distributed "MEMS Dust" Sensors', Shijun Qiu*, Dept of Mechanical and Electrical Engineering
Xiamen University, China, Alice M. Agogino, Jessica Granderson
Department of Mechanical Engineering, University of California, Berkeley

3. 'Smart Sensor Networks', David Rees, Smart Sensing Project
CSIRO Telecommunications and Industrial Physics
March 04, 2002 TIPP 1476
http://www.smartspaces.csiro.au/docs/SmartSensorNetworks.doc

4. 'AAAV Prognostic System Trade Study', Power Scavenging Technology
Conducted by Penn State ARL, January 15, 2003

KEYWORDS: MEMS, Nanotechnology, Microsystems, Power Scavenging, Condition-based Maintenance, Microsensors, Nanotubes

N04-198 TITLE: Persistent Illuminators as a Replacement for Tritium in Weapons Sights

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PM Force Protection Systems

OBJECTIVE: To develop a persistent illumination source as a replacement for tritium in weapons sights and illuminating instrument clusters.

DESCRIPTION: Illuminated weapon sights provide for an enhanced capability to acquire and engage targets, particularly in low-light levels. Currently, tritium is used as a persistent source of illuminating weapon sights because of its low weight, cost and complexity. Tritium, however, presents many safety and storage issues due to its radioactivity. Storage, transportation and disposal of tritium sources is expensive and burdensome. A persistent means of illuminating weapon sights without the use of batteries or radioactive materials is sought to maintain the current capability while greatly reducing the logistics of maintaining the capability.

PHASE I: Develop and demonstrate a concept/means to provide weapon sight/instrument illumination in all light levels without the use of batteries or radioactive material. The means for providing illumination should be low-cost, low-weight and easy to maintain, train and use. The illumination means should not require extraordinary handling, storage or usage issues with regard to protecting the environment and personnel health and life. It is desired that the illumination source persist for a minimum of 8 hours between refreshing/reloading/reenergizing (if required), with 24 hours or more highly desirable. Refreshing/reloading/reenergizing should require not more than 1 hour (less than 10% of one illumination period desired) to accomplish and should not pose any logistical burden. The illumination means shall be able to be incorporated into a weapon sight design that does not interfere with normal handling, training, or use of the weapon.

PHASE II: Develop, test and deliver a prototype small arms weapon sight that provides illumination in all light levels. The illuminated sight shall not pose and safety or operational use hazards. The weapon sights shall be capable of interfacing with and used with all current USMC small arms. The sight should provide a means to zero the weapon and shall maintain zero through harsh environment and repeated firings. The weapon sight shall not interfere with normal handling, training, or use of the weapon. The system shall be evaluated for operational compatibility, ruggedness and maximum performance. Develop a conceptual design for incorporating the illumination means into indicators and instrumentation clusters other devices (e.g. compass, radio set indicators, etc.)

PHASE III: Collect operational use data and evaluations. Modify, harden and test the system for military use. Prepare operators/training and maintenance instruction for the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: As a weapon sight, the system as described could be extremely useful for night security, rescue operations, riot control and local/state police activities. Furthermore, if such illumination means is capable with instrument and indicators, a large market exists for illumination of devices from watches to automotive instruments.

REFERENCES:
1. http://www.epa.gov/radiation/index.html

KEYWORDS: night vision devices; weapon sights; tritium; illuminator

N04-199 TITLE: Automated Weapons Assembly

TECHNOLOGY AREAS: Materials/Processes, Human Systems

ACQUISITION PROGRAM: Aircraft Carriers, PMS312, PMS378

OBJECTIVE: To develop an automated system for assembly processes for air-launched weapons using state-of-the-art high capacity and dexterous robotic manipulators and/or other automation technology.

DESCRIPTION: Prior to flight deck transfer and aircraft arming, air-launched weapons such as the Joint Direct Attack Munitions (JDAM) must be assembled from components. Currently, there are four Navy/Marine Corps JDAM variants, each with specific combinations of bomb body (1,000 or 2,000 lb. warhead, 500 lb. forthcoming), guidance set, strakes, lugs and fuze/sensor components. The components are stowed in separate containers and pallets and in varying unit loads. The JDAM uses conventional MK 80 series and BLU 100 series warheads, however the assembly procedure is more complex than that for the conventional bomb. JDAM assembly requires special tools and fixtures and, like conventional bombs, manpower. As with other guided weapons, test equipment is used to initiate Built-In-Test (BIT) for guidance assembly fault detection. Positioning of warheads on fixtures/transporters and attaching/assembling strakes, tail assemblies, associated lugs, rings, retainers, covers, etc. is the intended function of the system, with sensor/fuze related tasks accomplished by ordnance handlers as appropriate. BIT testing of the guidance system is also a desired, secondary automated function of the system. Although JDAM (or other weapon as may be determined) will be the primary weapon system of focus for Phase II and III demonstration purposes, all CVN based air-launched weapons will be examined to identify common areas with the objective of multi-weapon capable Phase II/III systems. Although relatively little assembly is required for some guided weapons, they require de-containerization, transfer to a transporter (skid/dolly) and BIT testing. The goal of this effort is the conceptualization, development, design, prototype testing and ultimate production of a shipboard system of robotic work cells capable of the fully automated assembly of carrier-based, air-launched weapon and countermeasure systems in a shipboard environment under varring sea-states.

PHASE I: Develop concept proposal for robotic manipulation and assembly of aircraft carrier based air-launched weapons aboard ship. Conduct a study to determine the guidance requirements, power density and electromechanical needs necessary to position major components on fixtures/transporters and to attach subassemblies under dynamic sea state conditions. Present findings with data, illustrations, related work, etc. to demonstrate feasibility of automated shipboard weapons assembly. Discuss concepts and components to be used for Phase II demonstration.

PHASE II: Design and develop a demonstration of automated assembly of JDAM or other air-launched weapons as predetermined in Phase I with TPOC. Model should be full or near full scale and demonstrate necessary dexterity to assemble designated weapon within confines of existing CVN-68 class bomb assembly magazine. Model system should demonstrate ability to assemble a ready service weapon from components. Demonstrate work cell stations necessary for parts placement, end effector/tooling changes and BIT testing and parts unpacking as appropriate. Demonstrate any ability to assemble other types of weapons/countermeasures with minimum retooling/programming. Demonstrate potential for manpower reduction through the automated accomplishment of a maximum number of weapons assembly tasks and associated tasks currently accomplished by humans.

PHASE III: Design and fabricate full scale, full capacity land based robotic work cell(s) for JDAM and/or other predetermined weapon(s). Geometry, control and power requirements of work cell will be identical to planned shipboard system. Number and types of weapons work cells to be produced will be determined by Phase II results, funding availability and existing preliminary designs deemed feasible by proof of concept modeling. Provisions will be made to facilitate ship motion simulator testing of load bearing devices and/or entire work cell as deemed appropriate. Subsequent to system refinement and all first article testing, a selected weapons work cell will be shipboard demonstrated. Land based work cells will be used for experimentation of new manipulators and manipulation techniques, end effectors and controls as dexterous manipulator technology advances and new weapons are brought online.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Innovative, automated assembly and production methods and devices are in high demand throughout the manufacturing industries. Automobile manufacturing, shipbuilding and all facets of machine production would benefit from new, high capacity, highly dexterous and intelligent manipulators.

REFERENCES:
1. Aviation Weapons Processes and Technologies (PowerPoint Brief) Mark Husni, NAWCAD Lakehurst, (732) 323-4081

2. Introduction to Robotics, Arthur J. Critchlow, MacMillan Publishing Co.

3. Federation of American Scientists, Military Analysis Network, http://www.sas.org

4. Sandia National Laboratories, Intelligence Systems and Robotic Center, http://www.sandia.gov

KEYWORDS: robot; manipulator; automation; weapon; assembly; work cell

N04-200 TITLE: Lightweight Fire Insulation

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Aircraft Carriers

OBJECTIVE: To provide the US Navy with cost effective light weight fire insulation to limit fire spread in steel construction and prevent flashover in composite construction.

DESCRIPTION: Navy ships are currently built with mostly steel construction. The US Navy also recognizes that the use of composite systems/structures may be considered in the design of next generation of surface combatants such as the CVN-21. One of the many design considerations for steel and composites is fire performance. The US Navy fire safety goals for surface ships include limiting fire spread (fire resistance), preventing flashover (fire growth), and maintaining tenability (smoke and fire gas toxicity). For fire resistance, the performance criteria is 30 minute or more rating with backside peak temperature rise less than 325 degrees F and average temperature rise less than 250 degrees F (UL-1709). Passive fire protection is used aboard US Navy ships to contain fire and prevent fire spread to adjacent or overhead compartments, and in the case of composite designs, to prevent flashover in ship enclosures. Navy currently uses high temperature glass fiber or mineral wool insulation products. Due to a combination of factors such as weight, attachment system, material and labor costs, there is a need for more cost-effective lightweight fire insulation system. Recent and past work performed by the US Navy indicates that current US Navy steel and composite designs do not meet the fire safety criteria without passive fire protection systems. In a recent cost estimate the material and labor for such fire insulation to protect composite designs was estimated at $40-50/ ft2. The suggested concept may include incorporation of insulation blankets, felts, coatings, and mats. Technical issues to be addressed include application and attachment of insulation products to the substrate, and the effectiveness of insulation products in meeting room corner and fire resistance tests. The insulation products should be cost effective and possess general and physical properties compatible with shipboard environment such as weight, adhesion, salt spray, impact, shock etc.

PHASE I: Evaluate and recommend alternative solutions both in the form of materials and passive fire protection concepts to meet the Navy goals for fire growth, tenability, fire resistance and fire endurance. Conduct limited tests to document recommendations. Small-scale characterization should include tests for flammability, fire resistance, general and physical properties. Quantify procurement and installation costs for the alternative solutions.

PHASE II: Scale-up one or two recommended insulation systems and perform the full scale mechanical and fire testing (such as ISO 9705 Room Corner Fire Test, and UL-1709). Propose the transition of technology solutions for ATD programs.

PHASE III: Develop and execute the plans for suitable transition/application for ships such as a multi compartment deckhouse in partnership with appropriate shipyard or defense contractor.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Steel construction and Composites are used in the commercial shipbuilding, offshore platforms, and aircraft industry where reduced flammability and improved fire safety is an issue. This work will benefit US Coast Guard and civilian shipbuilding industry.

REFERENCES:
1. Evaluation of Intumescent Coatings for Shipboard Fire Protection; U. Sorathia, T. Gracik, J. Ness, A. Durkin, F. Williams, M. Hunstad, F. Berry (submitted for publication in Journal of Fire Science).

2. Performance Requirements for Fire Safety of Materials in U.S. Navy Ships and Submarines; Usman Sorathia, G. Long, M. Blum, J. Ness, T. Gracik; 46th International SAMPE Symposium and Exhibition, Volume 46, 2001.

3. ISO 9705 Room Corner Fire Test

4. UL-1709

KEYWORDS: Fire Insulation, Fire Resistance; Fire Growth, Composites, Cost effective, Attach, Steel, Composites

N04-201 TITLE: Small, Cost Effective Mine Location Marker

TECHNOLOGY AREAS: Air Platform, Information Systems, Ground/Sea Vehicles, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: PEO(LMW); Unmanned Undersea Vehicles Program Office, PMS403

OBJECTIVE: Develop a near term method of marking a bottom or moored mine in shallow and very shallow water environments. This capability will advance the end to end organic mine countermeasures mission by reducing the navigation error when reacquiring mines for neutralization.

DESCRIPTION: Rapid progress is being made in developing and fielding UUVs capable of searching for and locating mine-like objects. However, reacquiring the mine-like object after a UUV has left the immediate vicinity of the target is problematic. The current platforms used to reacquire and neutralize mines suffer from limitations in navigation accuracy and resolution of searching sensors. These limitations lead to location inaccuracies that lengthen the search time and, so, increase the cost of the re-acquisition and neutralization systems. Development of an effective Mine Location Marker that can be dropped by a UUV and communicate to the reacquisition platform will significantly decrease re-acquisition time and cost.

A mine reconnaissance UUV would use its sensors to search a specified area for mine like objects. Once one or more have been identified, the UUV would deploy a Mine Location Marker and survey it in place with its sonar, providing x-y distances from the marker to the objects(s). These distances would provide very accurate relative, rather than absolute, locations. This information is then provided to the follow-on assets for identification or neutralization. They, in turn, would interrogate the Marker to identify its location and therefore reduce the re-acquisition error to inches. The Mine Location Marker itself requires innovative design and construction to meet the challenges of deployment in the very difficult environment of shallow and very shallow water. New acoustic communications methods or other ways of interrogation are needed for these high acoustic noise environments that make the standard acoustic communication used in current markers (pingers, beacons) ineffective. These areas of the oceans also experiences high currents. Innovative concepts will be needed to design the marker to remain stationary on the ocean bottom once deployed and not be moved by ocean currents and remain operational if buried by sediment. These aspects coupled with the need for low cost and small packaging require innovative technology developments for a successful Mine Location Marker.

The following information about the end product is given as guidance for the research and development to be carried out in the Phase I proof of concept and Phase II prototype development stages. The production version of the Mine Location Marker will need to include the following characteristics. It should provide real-time on-demand beacon type communication ("Here I am!") to the reacquisition platform so that its location can be established from a minimum distance of 1 kilometer threshold (with an objective of 5 kilometers. It should be able to be dropped from 20 feet above the bottom and remain stationary in 15 knot currents on a sandy bottom. It should be locatable if buried by two inches of sand. The Marker would not be recoverable, and, so, should be environmentally friendly even if destroyed by the mine neutralization process.

The production version of the Mine Location Marker would be integrated into the Mission Reconfigurable Unmanned Undersea Vehicle (MRUUV) Mine Countermeasure (MCM) payload program. MRUUV is a 21" diameter torpedo sized UUV that is able to be surface ship and submarine launched and recovered. The MRUUV will have a 5 cubit feet ( 21" diameter by 27 " in length) modular payload bay. More than one Marker would be stored in the bay and would be released from it one at a time. Consequently, the stowed Marker should occupy no more than 30 cubic inches with a goal of 10 cubic inches. The Marker should operate in water 600 feet deep and have a seven day life after deployment. Since a large quantity of Markers is likely to be used, the threshold production cost would be $1,000 per unit with a goal of $250 a unit.

PHASE I: Develop proof of concept design and architecture for the Mine Location Marker that provides the desired capability to mark and report, when queried, its location. The architecture and design should identify the transmission protocols and consideration of guaranteed access of service.

PHASE II: Develop a laboratory prototype for the critical components of the system. The laboratory prototype does not need to be demonstrated as a complete unit. However, critical technologies that demonstrate the "mine-like" object marking, the transmission and reception of data, and the anticipated power budget and packaging size for the prototype need to be present.

PHASE III: The contractor shall develop a system that can be integrated into the MRUUV MCM payload. The contractor would be responsible for the development and delivery of the device to include any components to be loaded into the MRUUV, the device transceiver, and the platform transceiver for command and control. A participating surface ship would deploy the device. The contractor and MRUUV program personnel would jointly work on integrating and deploying the device. The successful demonstration of the terminus would lead to the incorporation of the device in the MRUUV MCM payload.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Underwater salvage companies could utilize this technology to mark dispersed debris fields from wrecks. Undersea exploration companies or commercial fishing companies could leverage this technology to mark high density resources in the oceans. Other mine detection programs could also leverage this technology since this is a common problem.

REFERENCES:


1. Telecommunications Transmission Handbook, 3rd Ed., 1991 (or later), Roger L. Freeman, Wiley

2. Wireless PCS, 1997, Kuruppillai, Dontamsetti, Cosentino; McGraw Hill.

3. “Digital Signal Processing”, Oppenheim & Schafer

4. “Sonar Signal Processing”, Nielsen

5. Federal Business Opportunities. Solicitation number : N0002403R6308
Title : A--RESEARCH AND DEVELOPMENT FOR A MISSION RECONFIGURABLE UNMANNED UNDERSEA VEHICLE (MRUUV).
http://www1.eps.gov/spg/DON/NAVSEA/NAVSEAHQ/N0002403R6308/listing.html

6. Tiron, Roxana. “Unmanned Underwater Vehicles Not Quite There Yet, Navy Says,” National Defense Magazine, April 2002.
http://www.nationaldefensemagazine.org/article.cfm?Id=778

7. One can get sense of state-of-the art of underwater markers by searching the Internet on keywords such as underwater AND pinger or underwater AND beacon.


KEYWORDS: mines; UUV; navigation; neutralization; acoustic communications; command and control; pinger; beacon

N04-202 TITLE: JTRS Compliant Antenna for 21” Unmanned Undersea Vehicles

TECHNOLOGY AREAS: Air Platform, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: PEO(LMW); Unmanned Undersea Vehicles Program Office, PMS403

OBJECTIVE: Development of an innovative communications antenna for UUVs which are under privileged communication platforms due to their close proximity to the water and size of the vehicle which will entail new and revolutionary concepts.

DESCRIPTION: Rapid progress is being made in developing and fielding UUVs capable of searching for and locating mine-like objects, intelligence surveillance and reconnaissance, and anti submarine warfare. These UUVs are able to extend the reach of the platforms into previously denied areas and provide persistent surveillance. However, their impact has been hindered due to the limited communication capability.

UUV communications have several challenges. There is a limited power source that requires communications power to be as low as possible. The 21” diameter does not provide the space for a large aperture antenna thus the antenna must be conformal to the hull or retractable into the vehicle. UUVs are prone to constant movement due to wave action, antenna submergence, and high roll and pitch angles. The combination of these issues makes it difficult to establish or maintain a communications link.

The Navy has established that future radio procurements be made through the Joint Tactical Radio System (JTRS) program office. Therefore future UUVs will be required to use JTRS cluster 5 radios. The JTRS program office has approved a standard set of waveforms for fleet communication. The JTRS radio system will not be available until FY 08 but there are surrogate radios that may be used for experimentation.

The concept is to design an antenna system for a 21” UUV that will be able to communicate with Line of sight in excess of 512 kbs and Satcom in excess of 128 kbs. The radio must be compliant with the future JTRS requirements and must use an approved JTRS waveform.

PHASE I: The contractor shall select waveforms for line of sight and Satcom from the approved JTRS list and propose a communications system design that provides the desired data rate considering the space constraints and environmental conditions described above. The design should identify the transmission protocols and consideration of guaranteed access of service.

PHASE II: The contractor shall develop a laboratory prototype for the critical components of the system. The laboratory prototype does not need to be demonstrated as a complete unit. However, critical technologies will be demonstrated as part of the Antenna system (not packaged) in a similar environment to the condition described above.

PHASE III: The contractor shall develop a system that can be integrated into the MRUUV communication system. The contractor would be responsible for the development and delivery of the system to include any components to be loaded into MRUUV. The contractor and MRUUV program personnel would jointly work on integrating and deploying the device. The successful demonstration of the terminus would lead to the incorporation of the device in the MRUUV communication system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The interest in the worlds ocean has increased these last few years. Gas and Telecommunication companies are using increasing number of UUVs for undersea pipeline surveillance and repair. The antenna system design would increase the information that UUVs can communicate and therefore increase their effectiveness.

REFERENCES:
None available that directly address this issue.

KEYWORDS: Communication; UUV; Antenna; command and control; Radio

N04-203 TITLE: <u>UAV-based mine detection using a short pulse, high repetition rate, multicolor laser transmitter</u>

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PEO(LMW); Airborne Mine Countermeasures Program Office, PMS210

OBJECTIVE: Develop a UAV compatible lidar scanning and receiver system for use with a high repetition rate, short pulse, multicolor laser transmitter. The system will be used for airborne mine detection within the near-surface littoral zone.

DESCRIPTION: There is a need for Naval systems for tactical remote Airborne Mine, Minefield, and Obstacle detection and precision location throughout the Very Shallow Water (VSW), Surf Zone (SZ), Beach Zone (BZ), and inland operational environments. The near-surface littoral zone (VSW and SZ) is a complex dynamic region that poses a number of challenges to mine detection. Recent advances in laser transmitter technology have created an opportunity to utilize UAV-based remote sensing to identify mines within the near-surface environment through multiple wavelength interrogation and detection. In order to successfully accomplish the UAV-based mine detection mission, there is a need to develop receiver and scanning technology optimized for use with multiple wavelengths. A multiple wavelength laser has not been previously developed for UAV applications and will involve moderate technical risk in the areas of miniturization and environmental performance. This topic is soliciting responses in the Advanced Technology Development area for R&D. Technology areas that will be addressed include electro-optic sensors and technology within the sensors, electronics, and battlespace environment category.

PHASE I: The goal is to identify a receiver and scanner technology that, when combined with a high repetition rate, short pulse (~1 ns), multi-color laser transmitter, will enable detection of mines in the near surface region from a UAV platform. The scanning and receiver platform should be lightweight, electrically efficient, mechanically stable, and not require cryogenic cooling. Scanning rates should be 1 ms or better over a wide area. Phase I deliverables include a design for prototype development in Phase II. Risk reduction through limited experimentation is encouraged during the Phase I. Proposals that offer a unique and novel approach will be weighted more heavily than others. Offerors are encouraged to utilize innovative and creative approaches to the receiver and scanner

PHASE II: Build prototype scanning and receiver platform based on Phase I analysis. Evaluate system performance and document results. Make system available for optical tests with high-repetition rate laser transmitter.

PHASE III: Develop a system that can be integrated into the Naval UAV for operations throughout littoral zones operations for assessment, maneuver and targeting. At completion of the Phase II, the contractor working with the Navy will undertake formal follow-on tests and integration testing, at sea experimentation, and low-rate production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Lasers currently find a wide application in such diverse fields as medicine, entertainment and environmental monitoring. In particular a compact, short pulse, high repetition rate multi-color, scanning lidar may find uses in remote sensing (e.g. chemical and biological agent detection), as well as in target tracking and ranging applications.

REFERENCES:

1. A. V. Jelalian, Laser Radar Systems, Artech House, Boston, 1992

2. C. G. Bachman, Laser Radar Systems and Techniques, Artech House, Boston, 1979.


KEYWORDS: electro-LIDAR, UAV, underwater sensors; reconnaissance; minehunting; airborne

N04-204 TITLE: Pressure Tolerant Power Source for Off-Board Sensor

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO(LMW), Advanced Deployable System (ADS) Program Office, PMS183

OBJECTIVE: Develop an expendable power source for off-board sensors that will be deployed by the Littoral Combat Ship (LCS).

DESCRIPTION: The Advanced Deployable System (ADS) Program is developing off-board sensors for the Anti-Submarine Warfare (ASW) module of LCS. The sensors are strings of interconnected acoustic arrays that are terminated at surface buoys that pass array data to the LCS via radio links. High energy density power sources are needed to power the radios in the buoys and the preprocessing units that reside in the buoy anchor assemblies.

REQUIREMENTS
These power sources must provide at least 100,000watt hours at a 30 watt draw rate, operate safely, have a 5 year shelf life, and function unattended. Cost is an important factor since the power sources are considered expendable. The power sources in the buoys and in the buoy anchors can be, but do not have to be the same.

Possible technologies include lithium primary batteries, fuel cells, mechanical motion generation (buoy only), and perhaps sea water or other chemical reaction.

Safety, performance, shelf life, weight and volume are key technical parameters. The primary technical challenge (risk) is the development of a very high energy density power source that is safe and “affordable.”We are looking for innovative solutions to this technical challenge and will support further research and development and testing for promising solutions.

PHASE I: From innovative and emerging high energy density power source technology develop one or more conceptual designs for a power source module that has the potential to meet the requirements. The power source module includes the energy storage component, power regulation and distribution, safety devices, and packaging. Since the power source in the buoy anchor could be subject to 500 psi of pressure, it might be advantageous (not mandatory) to use pressure tolerant technologies rather than provide a pressure housing.

Each conceptual design should include a description, POA&M, and cost estimate of additional technology developments, assessments, and/or tests required to check, support, verify the concept.

In conjunction with ADS program personnel select the most promising concept(s) and proceed with the additional development, assessments and/or testing necessary to validate the approach prior to Phase II.

PHASE II: Develop a detailed design of the power source using the technology and approach selected and verified in Phase I. Build a prototype energy source and test it in the laboratory using a dummy load. (The prototype may be a scaled version of the required power source if the technology used scales credibly.) Identify an additional development or technology improvements needed based on test results. Develop a POA&M and cost estimate for a pilot production run of 10 full scale units to be used for further testing and/or certification.

PHASE III: Develop and integrate additional technology improvements if needed. Produce 10 units and support further testing/certification. A system integration contractor for the ADS program is intended to be selected at the end of FY05. The system integrator would be requested to evaluate the inclusion of the power module developed under this SBIR effort into ADS's SDD design. This would facilitate the SBIR contractor being a subcontractor to the system integrator.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This topic is intended to develop the technology for a large power module for undersea components. This module should be suitable for both military and commercial applications. Commercialization in the private sector would need to be researched but would undoubtedly involve powering of long term remote sensing equipment or underwater vehicles.

KEYWORDS: undersea, power, anchor, pressure-tolerant, safety

N04-205 TITLE: Underwater Acoustic Positioning System

TECHNOLOGY AREAS: Electronics, Battlespace

ACQUISITION PROGRAM: PEO(LMW); Naval Special Warfare, PMS NSW

OBJECTIVE: Develop an underwater acoustic positioning system that can provide GPS accuracy and can be deployed by airdrop or surface craft. The system will provide precision navigation for unmanned undereater vehicles (UUV), SEAL delivery vehicles (SDV), diver held Hydrographic Mapping Units (HMU) and Underwater Imaging Systems (UIS).

DESCRIPTION: Naval Special Warfare (NSW) and Explosive Ordinance Disposal (EOD) rely on underwater acoustic transponders to aid in navigation. The transponders provide X-Y coordinates of position within a confined navigational grid. However, it requires divers or surface craft to deploy and is only acurate within 25 yards. The current system does not have a direct link to GPS and is a temporary navigational grid with limited life. More precise commercial systems are being developed for use in sub-sea Oil and Gas fields and use Digital Spread Spectrum Technology to acousticly relay GPS data from a surface bouy to the underwater transponders. In essence, these systems promise to do for underwater navigation what satellite GPS has done for surface positioning and provide a stable long term common reference to multiple users simultaneously.

Research would be required to determine a means for synchronizing the underwater transponders to the master GPS Universal Time Clock (U.T.C.). It is envisioned that when a transponder is dropped into the water from either a surface craft or aidrop that it will be able to establish a GPS fix when it has anchored to the bottom without the need of a permanent surface acoustic bouy or floating antenna.

PHASE I: Research all commercial and military underwater acoustic positioning systems and develop an operational concept that will provide an underwater "GPS" type system.

PHASE II: Build and demonstrate an operational prototype of a multi-user (multiple UUV, divers, etc.) system.

PHASE III: Standardize design for use on all milatary UUVs and commercial AUVs and UUVs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system has commercial underwater and dive operations applications.

KEYWORDS: GPS; Navigation; Acoustic; Global; Positioning; Underwater

N04-206 TITLE: Multi-Vehicle Mission Planner for Unmanned Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

ACQUISITION PROGRAM: PEO LMW; Surface Mine Warfare Program Office, PMS 490

OBJECTIVE: Develop a mission planner for multiple unmanned systems. This planner will receive tasking information for a group of unmanned vehicles (UVs) treated as a single system. From this tasking, it will generate individual top-level mission plan requirements (search area, track spacing, ingress/egress routes, and mission abort procedures) for each unit in the team. The individual plans will be develop taking into account mission deconfliction requirements. The multi-vehicle mission planner will also provide feedback to the tasking agent about the planned tracks and mission path for each UV unit.

DESCRIPTION: The Littoral Combat Ship (LCS) system will rely on multiple unmanned vehicles to perform its focused missions (ASW, MIW, SUW). Flight 0 of the LCS program will rely on existing UVs with little or no modifications to each system. These UVs have been developed to operate as single units. Therefore, in any mission involving multiple UVs, an LCS Flt 0 operator will have to manually break up the group mission into individual UV subtasks before he/she can use the vehicle's mission planner. In breaking up the task, the operator will have to take into account deconfliction issues like planning the vehicle's search pattern to avoid sonar interference, or plan individual ingress/egress paths for each unit.

An existing high-level planner (e.g., MEDAL for MIW) defines tasking information such as the area to be searched or patrolled by the team of UVs, track-spacing requirements (or similar parameters related to mission performance), general ingress/egress paths, launch and recovery locations, and allocated mission time. An existing detailed vehicle mission planner produces a script in vehicle-specific language that defines the task a given vehicle must perform. The multi-vehicle mission planner (MVMP) to be developed under this topic will serve as an interface between the high-level mission planners and the vehicle-specific mission planner. On the vehicle side, the MVMP will break up the group tasking order into subtasks for each individual unit in the team, and produce the information required by the detailed planner to generate each unit's mission script. On the high-level planner side, the MVMP will receive the group tasking order information and feed back details about the planned tracks and transit paths for each individual unit.

It is envisioned that the MVMP will be a software agent capable of operating as stand-alone entity, or possibly embedded into the high-level planner. Moreover, the MVMP should have these attributes:

The MVMP must be tailored to output the information required by each type of UV being considered for the LCS program. It must provide the type of information that each detailed planner requires in the proper electronic format.

The MVMP must be capable of being converted into a Joint Architecture for Unmanned Systems (JAUS) compliant component. This will allow the MVMP to exchange information with JAUS-compliant high-level and detailed mission planners.

The proposed program development process is as follows:

PHASE I: Research all of the high-level and detailed mission planners for all the UV systems being considered for LCS Flt 0. Identify the common elements on both interface sides of the MVMP. Develop and demonstrate a prototype MVMP that executes as a stand-alone agent for the UV systems in LCS Flt 0.

PHASE II: Convert the Phase I MVMP into a JAUS-compliant component and demonstrate its operation with conceptual or prototype high-level and detailed mission planners.

PHASE III: Embed and demonstrate the MVMP into a prototype JAUS-compliant high-level mission planner, and demonstrate the ability to interface with at least one JAUS-compliant UV of each type (air, ground, sea surface, and underwater).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Unknown.

REFERENCES:

1. The Joint Architecture for Unmanned Systems, Vol. II, Reference Architecture Specification, Version 3.0, 13 Sep 2002

KEYWORDS: unmanned vehicles, littoral warfare, mission planning, antisubmarine warfare, mine warfare, surface warfare

N04-207 TITLE: <u>Multi aspect sonar classification for High Resolution Broadband Sonar (HRBS)</u>

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PEO(LMW); Explosive Ordnance Disposal Program Office, PMS-EOD

OBJECTIVE: Develop improved Multi Aspect Classification Processing (MADC) algorithms for advanced bottom and buried mine target detection and classification.

DESCRIPTION: MADC processing is a biologically inspired approach to mine detection and classification based on years of Office of Naval Research (ONR) and Defense Advanced Research Projects Agency (DARPA) funded research in the study of Dolphin (Tursiops truncatus) biological sonar (biosonar) and associated Fleet system development. DARPA recently funded a Dolphin Based Sonar (DBS) development effort, which designed wideband (80kHz) sonar that incorporates biologically based transmitter and receiver elements and image generation capability. This system was designed and developed during the 1999 – 2002 fiscal years and was tested at Applied research Laboratory, University of Texas (ARL-UT) Lake Travis test site and in San Diego bay. Target sets detected consisted of eight Office of Naval Intelligence (ONI) certified mine simulators at ARL-UT and mine simulators with associated bottom clutter objects in San Diego bay. Approximately 50,000 sq. meters of B-2 bottom type data were ensonified using the DBS in a manner similar to Unmanned Undersea Vehicle (UUV) search patterns. A rich data set was collected. The DBS signal processing was successful in demonstrating basic functionally of an initial multi aspect detection and classification processing scheme applied to the San Diego bay data. The multi aspect detection and classification approach showed great promise. ONR has since funded efforts to advance portions of the approach for transition to existing/planned UUV platforms.

Further efforts are required to refine the MADC process for incorporation into UUV sonar sensors. Development of Code, which must run on standard UUV computer architecture (PC104+ systems running advanced windows OS) that is compact, fast and provides for:
1) Image generation from extracted data "snippets", for either acoustic feature based or synthetic aperture type images to aid classification by automated processes or visually recognizable by a sonar operator are needed.
2) Classification techniques based on multi aspect returns for and associated feature sets of the mine contact data need to be developed for enhanced classification performance.
3) Refined and more fully developed acoustic focusing processes (motion compensation algorithms).

PHASE I: Refine and expand the existing DBS data analysis process developed under both DARPA and ONR sponsorship. Extend existing processing of target snippet data sets to better classify multi-aspect returns. Currently only a few energy-based features are used to classify targets as mine-like. Additional classification approaches need to be developed to provide positive classification as mine type.

PHASE II: Develop improved motion compensentation algorithms for a variety of UUV platforms. Demonstrate improved mluti aspect detection and classification as compared to the SSC SD processing efforts (Baseline and new work).

PHASE III: Build and test streamlined, compact and fast code to replicate existing DBS signal processes and improved classification processing developed in phase I and II. Successes will transition to the Long Term Mine Reconnaissance Program - AN/BLQ-11 sonar (PMS-403).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Underwater unmanned vehicles (UUVs) are currently being investigated as improvements to the U.S. Navy Fleet capabilities for mine countermeasures operations. These vehicles need improved sonar for mine detection and classification capability.

REFERENCES:

1. Office of Naval Research Future navy capabilities Organic Mine Countermeasures web site - http://www.onr.navy.mil/fncs/mcm/

2. Houser, D., Martin, S.W, Phillips M., Bauer, E., Herrin, T. and Moore P. Signal Processing Applied to the Dolphin-Based Sonar System. Proceedings of the Oceans 2003 conference. San Diego, September, 22- 26, 2003. PP 297-303 (http://oceans2003.org/main/AdvanceProgram.asp)


KEYWORDS: Remote minehunting systems; RMS; mine countermeasures; mine detection and classification; multi aspect detection; Unmanned Underwater Vehicle sensors.

~~N04-208 TITLE: Acoustic Surveillance Multi-Array Search Aid~~

CANCELLED

N04-209 TITLE: Solid-state LIDAR Chip

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: PEO(LMW); Airborne Mine Countermeasures Program Office, PMS210

The Navy is using a Streak Tube Imaging LIDAR (STIL Light Detection and Ranging) to provide a mine imaging capability for the AN/AQS-20A system that is deployed from various platforms. The STIL being integrated into the AQS-20A is a modified version of the STIL developed by the Office of Naval Research. The STIL is an active imaging system using a pulsed laser transmitter and a streak tube receiver to time-resolve the back-scattered light from the laser pulses. The laser beam is diverged in one dimension using a cylindrical lens to form a fan beam. A conventional lens focuses the back-scattered light onto the streak tube photocathode, and is time (range) resolved by electrostatic sweep within the streak tube. This generates a 2-D range-azimuth image on each laser pulse. The in-track dimension is sampled by adjusting the pulse repetition frequency (PRF) of the laser to the forward speed of the vehicle, thus sweeping out the three-dimensional ocean volume in a push broom fashion. There are no requirements for a mechanical scanner and no critical positioning since the streak tube images all ranges/depths simultaneously.

There is currently a potential for development of a solid state LIDAR chip with range capability within industry. A C-MOS chip with a linear array of 1024 pixels, each with 128 range bins (providing the range capability) could replace the EOID streak tube, camera and high voltage electronics. These linear arrays could perform better than our current receivers but at a much lower cost (perhaps a savings of as much as #200K per unit).

OBJECTIVE: To replace the current streak tube, camera and high voltage electronics used in the AN/AQS-20A Electro-Optical Identification Sensor (EOID) with a solid state C-MOS chip.

DESCRIPTION:

PHASE I: Develop a baseline design and program plan for development of the C-MOS LIDAR Chip described under the objective, and conduct any preliminary risk reduction analysis and/or experiments to remove obstacles to production.

PHASE II: Update baseline design into a pre-production prototype design and continue risk reduction analysis and/or experiments to remove obstacles to production.

PHASE III: Develop and test a prototype C-MOS LIDAR chip including incorporation into an AQS-20A EOID Engineering Development Model and support of at-sea testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Any electro-optic sensor using streak tube imaging technology (or any other low-light amplification technique) could potentially use this technology.

REFERENCES:
1. Swartz, B. A., J. D. Cummings, "Laser range gated underwater imaging including polarization discrimination", Underwater Imaging: Photography and Visibility, SPIE V. 1537, 1991

2. Smolka, G. and B. Swartz, "Lasers open windows into the briny deep", Photonics Spectra, June 1994.

3. Ulich, B. L., P. Lacovara, S. E. Moran, M. J. DeWeert, "Recent results in imaging lidar", Advances in Laser Remote Sensing for Terrestial and Hydrographic Applications, SPIE V. 3059, April 1997

4. Strand, M. P., "Underwater Electro-Optic System for Mine Identification", Naval Research Reviews, 1997

5. Coles, B., "Laser Line Scan Systems as Environmental Survey Tools", Ocean News and Technology, July/August 1997.

6. McLean, J. W., J. D. Freeman, R. E. Walker, "Beam Spread Function with Time Dispersion", Applied Optics V37, No 21, 20 July 1998.

7. Walker, R. E. and McLean, J. W., "Lidar equations for turbid media with pulse stretching", Applied Optics V38, No. 12, 20 April 1999

8. McLean, J. W. and R. E. Walker, "Lidar equations for turbid media with pulse stretching", Airborne and in-Water Underwater Imaging, SPIE V 3761, July 1999.

9. McLean, J. W. "High Resolution 3-D Underwater Imaging"

KEYWORDS: LIDAR, STIL, laser, streak tube, mine, imaging, range, mine countermeasures

N04-210 TITLE: Avoidance of Twinline Towed Array Entanglement

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

ACQUISITION PROGRAM: PEO(LMW); Fixed Surveillance Systems Program Office, PMS485

OBJECTIVE: Design a physical device to attach to a towed twinline system that will mitigate entanglement in fishing lines and nets.

DESCRIPTION: Twinline arrays that use paravanes to provide separation distance between the two arrays are susceptible to fouling in the presence of fishing line and nets. SURTASS missions are nominally 75 days on station in the Western Pacific where they often encounter areas of intense fishing activity. Development of a physical device that could be attached to the array assembly that would minimize entanglement problems would improve systems operational availability and mitigate potential damage and loss of arrays. During missions SURTASS ships typically conduct on-board repairs that require array retrieval. This system must be designed such that it does not present a danger to array operation personnel during array handling procedures. Furthermore, this system should be designed so that it minimizes damage to the fishing lines and nets it encounters.

PHASE I: Develop a design for a twinline antifouling device. The Phase I work must provide a design that will be the basis for fielding a prototype system for a Phase II effort. The system should have an operational availability of 95% given an average of five (5) possible fouling events every 24 hours of operation with a possible maximum of twenty (20) encounters a day. The system must be safe to handle by ship's personnel and should minimize damage to fishing equipment.

PHASE II: Build and test a prototype twinline antifouling device. In addition to fabricating the prototype system, the offer must design a program that builds, tests, and provides time and resources for improvements and re-testing. The offerer must also design suitable experiments to fully test the device for safety and effectiveness against multiple types of fishing activity. The system must be capable of safe handling by back deck personnel during at-sea array repair and reconfiguration up to sea state 4.

PHASE III: Transition the proven system to the twinline arrays used by the SURTASS program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The twinline antifouling device will improve the operational availability of multiline arrays that use paravanes in areas co-existent with fishing activity. In addition to its benefit to the Navy, it also has potential benefits to the offshore oil industry.

KEYWORDS: arrays, fouling, fishing, twinline, paravanes, operational availability.

N04-211 TITLE: Heat and Humidity Cumulative Exposure Sensor

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: 2T Cog Ammunition Program Office, IWS 3C

OBJECTIVE: To develop a heat and humidity exposure sensor that will monitor the history of the total thermal energy (heat) absorbed and quantity of water/moisture seen by an ordnance item during storage and deployment.

Prolonged heat exposure accelerates the aging process of explosives, propellants and solid rocket fuel. High humidity adversely affects the service life of any component, whether due to corrosion, stress corrosion cracking, or other chemical interaction. The sensor must be a non-power source-requiring sensor.

DESCRIPTION: This proposal involves the selection or development and incorporation of cumulative heat and humidity sensors on or in an ordnance or electronic item. The sensor must be capable of accumulating the heat and humidity histories seen by the item over time. The sensor will provide an easily readable indication of the amount of heat, moisture, or environmental stress to which the item has been exposed during its life. The sensor must be a non-power source-requiring sensor. The sensor must go beyond current time-temperature indicators and one-time maximum-humidity indicators to provide a combined, accumulated indication of environmental stress that can be used to decide whether an item must be pulled from the supply chain, to assess whether the item has sufficient life remaining to be issued, and to allow users to select the "freshest" items for critical missions while using "stale" material for less critical activities such as training.

PHASE I: Develop a sensor that can monitor the heat and humidity exposure on or in ordnance items. The technology should be suitable for a final product that will be packable with ordnance items such as ammunition cases, projectile storage "tanks," or missile shipping containers. The sensor will need to incorporate a cumulative capability to determine the total amount of heat and moisture seen by the items.

PHASE II: Develop and test the sensor under various temperature and humidity scenarios to be provided by sponsor. The samples chosen will have been analyzed previously using heat flow micro-calorimetry and moisture analyzers per specifications determined by government agency. Confirming samples will be analyzed to validate the sensor.

PHASE III: Testing of the items with sensors in the fleet and under various simulated conditions will be determined by the government in conjunction with the sponsors.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Cumulative heat and humidity sensors will be applicable to monitoring the usability of electronic, chemical, or biological material under prolonged service or storage. They can apply to anything that exhibits a shelf life, aging, degradation, or reactivity with heat or moisture. The grocery and commercial foodstuff industry is beginning to apply shorter-life temperature sensors to reduce the amount of excess margin included in “use before” dates, although longer-duration sensors that can monitor temperature and humidity are not available at low cost. The World Health Organization has specified time-temperature indicators be packed with all its vaccines. These cover exposures of up to four years, but again do not address humidity.

REFERENCES:
1. “New Low-cost Temperature Sensor,” RFID Journal, July 19, 2002. Available online at http://www.rfidjournal.com/article/view/28/1/1/

KEYWORDS: humidity, moisture, temperature, heat, sensor, shelf life, and storage

N04-212 TITLE: Technology for Advanced Ship Designs

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: National Shipbuilding Research Program (NSRP) Advanced Shipbuilding Enterpr

OBJECTIVE: The objective of the project is to develop and implement innovative design and material technologies that will reduce the cost to design and build ships and thereby reducing the cost of military ships and improving the competitiveness of the US shipbuilding industrial base..

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 topic deals with the Product Design and Material Technologies (PDMT) Major Initiative and the associated Sub-Initiatives. This entire plan is available for review on the World Wide Web at http://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 design concepts. Proposals should indicate which areas are being addressed. Awards are planned to be made to the highest rated proposals for the PDMT Major Initiative.

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 an integrated project execution and implementation team will improve transition potential and is strongly encouraged. Shipbuilding industry contacts are available at http://usashipbuilding.com under the “Panel Pages” button.

Proposals under this topic must address at least one of the following research areas related to the SIP:

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 support the design of high performance, low cost ships and ensure U.S. shipyards’ market differentiation in the ships of the future. Focus areas to consider may include:

· Advanced design, simulation, analysis, estimating -- for example, develop software programs that can calculate the square footage surface area for each part that is designed and that requires painting, and then be able to link that information to paint shop bidding, estimating and inventory control computer systems
· Automated cargo handling capability

· Protective coatings
· Advanced composite structures
· Innovative hull forms and drag reduction technology
· Advanced propulsion equipment concepts
· Regulatory implementations associated with promising advanced product designs and materials

PHASE I: Prove feasibility for improvements being developed and detail where and why they will impact shipbuilding affordability, particularly in the design phase of the project. Include a Return-On-Investment (ROI) analysis for industry implementation. If proposer is not a U.S. shipyard, recommend close collaboration with a shipyard customer to validate feasibility and marketability.

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 PDMT Panel, develop a commercialization (Phase III) plan by encouraging coordination with Panel members. The plan is to include 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 are applicable to both military and commercial shipbuilding practices, and will be marketable to the shipbuilding industry.

REFERENCES:
1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org

KEYWORDS: shipbuilding; affordability; design; processes

N04-213 TITLE: Advanced Structural Development for Cargo Stowage Systems

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Auxiliary Ships, Boats and Craft, Program Manager, PMS325, PEO SHIPS

OBJECTIVE: Develop a durable, light-weight, cargo stowage system that will allow for increased and efficient stowage capability and safer cargo handling conditions for the crew. The cargo stowage system replaces the current steel rail diagonal dunnage system aboard current cargo carrying Naval Vessels.

DESCRIPTION: The current steel rail diagonal dunnage system utilized to stow cargo aboard Naval Vessels is heavy and requires extensive use of filler material such as wood blocks to fill space between portable dunnage stanchions and the cargo. The placement of wood blocks between stanchions and cargo is very time consuming and is necessary in order to secure and restrain the cargo. Weight and maintenance savings could be realized by eliminating the concrete product that is installed on the deck between the diagonal steel rails of the existing system in order to level the surface for travel of fork lift trucks. The proposed stowage system presents a unique challenge due to the potential for high density cargo and the corresponding loads placed that would be placed on the system when in a seaway. The solution proposed should be forklift compatible and should allow for flexible stowage configurations that can be rapidly configured by minimal ships personnel.

PHASE I: Conduct a feasibility analysis to determine the best durable, lightweight material and structural concept for a cargo stowage system. Provide a preliminary concept design and an associated component validation plan.

PHASE II: Finalize the design from Phase I and fabricate prototype components. Validate components using laboratory testing and provide results.

PHASE III: Construct a full scale prototype, including ship interface, based on Phase II results for testing in a shipboard environment. As applicable, the small business will work with the Navy or Industry to transition the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is an immediate benefit to commercial cargo vessels in applications where the ship will be transporting palletized and non-containerized cargo. The weight savings of a new system will allow for an increased cargo capacity and profit per voyage.

REFERENCES:
1. Lightweight Composite Stowage System (LCSS) Approval Plan, 3 July 2003 (Available form PMS325D)

2. System Specification for Dry Cargo/Ammunition Ship, T-AKE 1 Class (Available from PMS325D)

KEYWORDS: Cargo; Stowage; composite; grating; stanchions; dunnage

N04-214 TITLE: Comprehensive Spectrum Management for Wireless Networks

TECHNOLOGY AREAS: Information Systems, Electronics

ACQUISITION PROGRAM: Smartship Program, PMS 400F

OBJECTIVE: Develop advanced hardware and software technologies for analysis and management of the RF component of shipboard wireless networks.

DESCRIPTION: Wireless communications are key to realizing the goals of Network Centric Warfare. Implementation of wireless networking in a DoD environment offers numerous challenges. Many of those challenges have been or are being addressed by technology development or policy efforts. However, spectrum management remains a significant issue.
This topic seeks innovative and comprehensive methods for managing the RF spectrum utilization of a wireless network. Mechanisms are needed to provide for frequency agility in a wireless network operating within the common unlicensed bands (2.4 GHz and 5.8 GHz) as well as the agility to move outside those bands when appropriate. The solution developed will need to address improvement of throughput through avoidance of interference as well as the ability to avoid the usage of specified frequencies when required by policy. Comprehensive spectrum management should include provisions for spectral analysis and characterization, RF emitter location techniques, RF power management and directional and smart antenna utilization. Developed spectrum management capabilities must be applicable to wireless access points and client devices and must, in their final form, be capable of meeting requirements for Naval and military use including those for ruggedization, electromagnetic compatibility, information assurance and open architecture. The focus of this topic is wireless networks within the complex RF environment found shipboard. However, developed solutions should have applicability for more typical shore-based installations as well.

PHASE I: Demonstrate the feasibility of spectrum management for a wireless network system that utilizes the common unlicensed frequency bands and has the ability to shift to other desired frequency bands. The concept proposed should address specific technologies and protocols to be utilized or developed. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the system, component and protocol designs and fabricate a prototype system. Perform laboratory tests to validate the performance goals established in Phase I and demonstrate the systems ability. Develop a plan to design, fabricate and install a system on board a naval vessel.

PHASE III: Working with the Navy and commercial industry, develop test and install a system in a naval environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL:
Technologies developed for spectrum management that provide improved throughput and increased utilization for wireless network applications have applicability in many commercial applications, and will be of particular interest for applications with complex or sensitive RF environments such as commercial shipping applications, communications industry facilities, hospitals and airports.

REFERENCES:
Information on industry WLAN standards:
1. http://grouper.ieee.org/groups/802/11/

2. ANSI/IEEE Standard 802.11, 1999 Edition

3. IEEE Std 802.11b-1999

4. IEEE Std 802.15.1-2002

Information on DoD wireless requirements:
5. Draft DoD Directive 8100.bb: Use of Commercial Wireless Devices, Services and Technologies in the DoD Global Information Grid

6. MIL-STD-464, Electromagnetic Environmental Effects Requirements for Systems

KEYWORDS: wireless networks, network management, spectrum management

N04-215 TITLE: Sensor Synchronization Technologies

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: ACAT IV, Smartship

OBJECTIVE: Develop technologies that allow time synchronization of events collected from distributed smart/digital sensors.

DESCRIPTION: The use of sensors on Navy ships is expected to increase in coming years in order to meet Navy tactical and economic goals. Sensors are required for implementing advanced automation and cost saving capabilities such as condition-based maintenance. While time synchronization of events on all sensors is desirable, if achievable, the specific focus of this topic is on achieving a method for time synchronization for smart/digital sensors utilizing standards and open architectures as much as possible. In general, a smart sensor as a device forms the interface from the physical world to the electrical domain. Typical smart sensor measured domains are: thermal, magnetic, mechanical, radiant, and chemical. Ideal smart sensor systems will consist of a number of multiplexed sensor elements, sensor-specific front-ends modifiers and microcontrollers or DSPs, and wired and wireless network interfaces. Some important smart sensor system design targets are: a high-accuracy, a high dynamic-range, a high-speed, low-power consumption, a high reliability and low costs. Issues such as determinacy and latency can severely impact the performance and utility of a smart sensor network. Many advanced applications involving sensors require the ability to know when the events have been detected by the sensors happened according to a common reference time scale recognized by the data collection systems.

The technology solutions proposed should address standards such as the proposed and final standards from the IEEE 1451 committee.

PHASE I: Demonstrate the feasibility of time synchronization of smart sensor events. Establish Phase II performance goals and key developmental milestones. Prepare a system concept and conduct limited testing of the concept to support feasibility demonstration and recommendations for Phase II.

PHASE II: Finalize the system and/or algorithm designs, as appropriate, and demonstrate a working prototype of the system or algorithms. Perform laboratory tests to validate the performance goals established in Phase I and demonstrate the systems or algorithms ability to time synchronize smart sensor events. Demonstration should highlight how the developed technology can be utilized in military and commercial applications.

PHASE III: Working with Navy and commercial industry, finalize the system design, build a final-version system and demonstrate in a shipboard environment.

PRIVATE SECTOR COMMERCIALIZATION POTENTIAL: Many commercial interests, such as the manufacturing and aerospace industries, are relying increasingly on automation, which means an increasing reliance on sensors. In many instances, quality control and physical control of a system requires accurate time synchronization of sensor events. Many commercial applications in these and other industries will benefit from development of smart sensor time synchronization capabilities.

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. IEEE 1451.3, "Standard for a Smart Transducer Interface for Sensors and Actuators, Digital Communication and Transducer Electronic Data Sheet (TEDS) Formats for Distributed Multi-drop Systems"

KEYWORDS: sensors, smart sensors, sensor networks, synchronization, timing

N04-216 TITLE: Power generation for weight and space limited USV systems

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

OBJECTIVE: Develop a compact, light-weight power generating system that is capable of producing 40 kW or more that will operate onboard Unmanned Surface Vehicle (USV) platforms based on 7 and 11 meter Rigid Hull Inflatable Boats (RHIBs) having limited weight and space availability.

DESCRIPTION: USV crafts of the future will require a substantially greater amount of power than is currently available to support more sophisticated command and control equipments/modules. Currently available standalone generators that produce approximately 40 kW of power weigh about 1600 lbs. Current USVs, based on 7 m RHIBs, have a payload capacity of approximately 3000 lbs. The current available technology for power generation would take up more than half the payload of a USV platform. This would, limit the size and weight of the mission modules that could be added to the RHIB to perform fleet multi-mission operations.

The Navy seeks an innovative, compact, lightweight, 40 kW (or more) power-generating system for a USV platform based on a 7 and 11 meter RHIB. An example of one possible approach is to explore the generation of high power (40 kW or more) using low weight generators (500 lbs or less) that extract power directly from the engines of a USV. Alternatively, small, lightweight standalone power sources are also of great interest. The solution proposed will consider the space restrictions onboard a USV and will address any issues involving mechanical interface to the engines.

PHASE I: Demonstrate the feasibility of the proposed concept to develop a small, lightweight power generating unit. Define the proposed concept of operations and projected capabilities. Develop key component technological milestones.

PHASE II: Fabricate and demonstrate a prototype of the system developed in Phase I. Conduct necessary testing to refine concept of operations and projected capabilities. Provide drawings, mounting and wiring sequences. Conduct lifecycle testing and provide system cost estimates.

PHASE III: Conduct USV testing to evaluate an integrated system performance. Develop a plan to transition the generator system to production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Multiple service (USCG, USMC, US Army), commercial boats, or any other engine driven vehicle could be in need of a small and lightweight power generation unit.

REFERENCES:
1. RHIB plans (provided upon request)

KEYWORDS: Unmanned Vehicle; Rigid Hull Inflatable Boat; Power generation

N04-217 TITLE: Multi-function Connectors for Shipboard Equipment

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate multi-function connector mechanisms for shipboard equipment. Mechanisms must be capable of physically securing a variety of sizes and shapes of equipment and provide interfaces for power and data resources required by the equipment.

DESCRIPTION: Due to reduced manning environments and modularity requirements envisioned for future surface combatants, the development of rapidly and easily reconfigurable equipment will in turn support the achievement of mission requirements and will reduce the life-cycle costs associated with the equipment. The Navy seeks the development of a set of “universal”, standardized, multi-function connectors that can be used to physically secure various equipments to the structure of the vessel while simultaneously and transparently providing other required interfaces. Required interfaces of key interest are power and data communications. Other interfaces are of interest, such as for fluids (coolants, lubricants) and gases; however, development of these interfaces should not be the primary concern of the proposed concept and should not impact the development schedule proposed for the required key interfaces of power and data communications. The vision is a “plug-and-play” capability with the ability to place a piece of equipment on the vessel and secure it to the structure using these mechanisms. At this point the installation would be complete as all other necessary system interfaces are accomplished via these same connector devices.

The proposed mechanisms, in their final form, should meet several criteria to be useful to the Navy:

- The objective is to have a minimum number of types of connectors to satisfy the variety of interface needs. Interfaces should be as flexible as possible. For example, power connections should be able to handle a wide variety of different current and voltage requirements.
- Connectors must meet all Navy and military requirements for ruggedization such as for strength, shock, vibration, exposure to salt and the elements.
- Connectors must meet requirements for Electromagnetic Compatibility and other requirements for non-interference with other equipment.
- Connectors must meet requirements for safety.

PHASE I: Develop and demonstrate the feasibility of a concept and design for multi-function connection mechanisms that will meet Navy requirements.

PHASE II: Fabricate and functionally validate prototypes of the mechanisms developed in Phase I. Provide acquisition and lifecycle cost estimates.

PHASE III: Conduct testing to evaluate performance in Navy environment and validate design to requirements. Develop plans for shipboard certification and application. Develop a manufacturing and commercialization plan including purchase, installation and life cycle cost estimates.

PRIVATE SECTOR COMMERCIAL POTENTIAL: “Plug-and-play” capability has become ubiquitous in industry. The types of connectors being developed under this project will appeal to industries that develop or manufacture large systems of systems or systems requiring frequent reconfiguration such as the commercial shipbuilding and aviation industries.

REFERENCES:

1. MIL-STD 901D
2. MIL-STD 167
3. MIL-STD 610E
4. IL-STD 461E
5. IL-STD 464A

KEYWORDS: Multi-function connector, Universal connector, equipment interfaces

N04-218 TITLE: Algorithms for Rapid and Accurate Depth Localization of Targets for Mine Avoidance

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

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate improved approaches for rapidly and accurately assessing the depth of mine like objects.

DESCRIPTION: In-stride mine avoidance operation requires fast and accurate localization of the depth of mine-like targets. This localization supports operating concepts that distinguish bottom from volume and surface mine-like objects, in order to eliminate false ship maneuvers against non-mine bottom objects. Additionally, by increasing the range at which mine-like objects can be classified and localized, the severity of the avoidance maneuver is reduced as is the corresponding acoustic signature associated with the maneuver. This reduction in ship signature would reduce the likelihood of actuating the mine.

Current high frequency sonar processing techniques are capable of long-range, vertical-target localization under direct path conditions; however, they are not capable of accurate localization under multi-path conditions. Advanced algorithms that would provide accurate depth estimation at a long-range, between 1000-5000 yds, in the shallow water environment in the presence of significant ray bending and multi-path conditions are needed. Additionally, these algorithms should be adapted to run in real-time, in order to support rapid localization after classification for the time-critical mine avoidance application. Real-time is defined as the ability of the algorithm to localize and detect each mine like object from the sonar within a 1 second time interval

PHASE I: Demonstrate the feasibility of mine-like target localization algorithm to support both direct and multi-path conditions. Define a proposed concept and provide a preliminary design of a prototype system or device.

PHASE II: Finalize the prototype design. Fabricate the critical components of the prototype system and conduct laboratory characterization experiments. Provide a detailed test plan and conduct a scaled capabilities demonstration of the prototype.

PHASE III: Working with the Navy and Industry, the small business will adapt the algorithms developed for DD(X) combat systems use as installed in future ship construction.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This concept is applicable to commercial and luxury vessels for localization of surface and sub-surface objects. The technology developed would be adaptable for commercial collision avoidance systems.

REFERENCES:
1. T. L. Henderson, “Wide-band Monopulse Sonar: Processor Performance in the Remote Proﬁling Application,” IEEE Journal of Oceanic Engineering,vol. OE-12, no. 1, Jan. 1987, pp. 182-197.

2. T. L. Henderson, “Broadband Signal Processing Methods for Monopulse Direction Finding,” Proceedings of the IEEE Oceans ’90 Conference, Sept.24-126, 1990, pp. 491-496, IEEE Cat. No. 90CH2858-9.

3. T. L. Henderson, “Matched Beam Theory For Unambiguous Broadband Direction Finding,” Journal of the Acoustical Society of America, vol. 78, no. 2, Aug. 1985, pp. 563-574.

KEYWORDS: mine; localization; multi-path; algorithm; sonar; processing

N04-219 TITLE: Object Avoidance for Unmanned Surface Vehicles (USVs)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS501

OBJECTIVE: Develop a suite of inexpensive, scalable and portable object avoidance tools for small to medium size unmanned surface vehicles (USVs) usable in a wide range of maritime environments.

DESCRIPTION: A multitude of future technology studies, as well as operational experience, has identified the potential value of autonomous systems. The benefits range from manpower reduction and force multiplier, to performing missions too dangerous for manned platforms. For these reasons, substantial technology investments are being made or planned in this area. USVs have the potential to support many logistics, surveillance and fire support functions for the Navy. A severe limiting factor for the fielding of a fully autonomous USV is a robust, affordable object avoidance capability to accompany other existing navigation elements. Until this technology is developed, the Navy will be limited to semi-autonomous surface vehicles (human-in-the-loop navigation).

The Navy seeks portable and scalable object avoidance tools that will provide the ability to detect obstacles at a sufficient range to allow the appropriate "avoidance maneuver". A conservative detection range of 75 yards is targeted. Proposals should address varying objects both size and speed with a variety of environmental conditions. Important developmental criteria for the proposed object avoidance tools are:
- The use of COTS hardware where practical
- Applicability to a wide range of object avoidance applications (DoD and private sector)
- Adaptable to a variety of hardware components within specification, thus reducing the necessity of redundant software/hardware for similar applications
- Scalable to be useful for medium and small USV systems,

PHASE I: Demonstrate the feasibility of a surface object avoidance system, Address the development of interface specifications and platform independent hardware (sensor, processor) specifications. Develop performance metrics and associated benchmarks to evaluate a prototype system.

PHASE II: Fabricate and demonstrate a prototype system developed in the Phase I effort. Through laboratory testing, validate the properties of the system as defined in Phase I. Revise drawings, descriptions, and projections as applicable.

PHASE III: Refine the suite of tools and continue evaluation in test environments. Develop a capability transition package that includes documented software, hardware and interface specifications, interactive training package, prototype hardware and test environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability has a broad range of potential for other federal, state government and private sector applications, including port security, homeland defense, luxury/pleasure boat navigation systems and river transport navigation systems.

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

2. Mission System Technical Architecture Requirements, N00024-03-R-2309 Attachment J-5.

3. Preliminary Design Interim Requirements Document for Littoral Combat Ship (LCS) Flight 0.

4. Open Systems Acquisition and Supportability Guide, 31 December 1996.

KEYWORDS: autonomous; navigation; avoidance; recognition; optics; system

N04-220 TITLE: Embedded Pressure Sensors for Automation and Control of Fluid Valves

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

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Development of non-intrusive, embedded, low-profile and low-cost sensors to remotely and possibly wirelessly provide mechanical system data (pressure drop, absolute pressure on each side, flow, flow direction) on a valve within a fluid system.

DESCRIPTION: Utilization of advanced machinery control systems for fluid, propulsion, damage control and other shipboard systems are predicated on the ability to receive a greater amount and quality of system data than is currently available. These advanced control systems are being fielded to provide a number of capabilities including: higher automation/less manning, greater safety, greater efficiency of machinery, and greater survivability. With these improvements comes the need for embedded sensor technology within the system and/or hardware (i.e. valve assembly) - inside or adjacent to the flow of fluids or gasses in pipes, heat exchangers, etc. It is desirable that the sensors be small and non-intrusive as well as inexpensive so as to be installed in a redundant manner. It is also desired that the sensor be able to communicate either wired or wirelessly, if possible, with system controllers and with each other. The sensors proposed, for example, may exist within fluid pipes (water, salt water, lube oil, hydraulic fluid) or heat exchangers, or may be portable where they may be attached to the outside of pipes anywhere in the system to measure flow. They key features for development are accuracy, ruggedness, low-cost, and the ability to work and communicate with each other. The solution proposed will be assessed for back-fit as well as future combatant applications.

PHASE I: Demonstrate the feasibility of an embedded sensor for a valve application within a fluid system. Address proposed communication methodologies. Develop key component technological milestones.

PHASE II: Develop and construct a prototype sensor package. Complete component design and conduct laboratory characterization experiments.

PHASE III: Working with the Navy and Industry personnel, construct a full-scale prototype for testing within a working fluid system on a future combatant platform such as DD(X).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced machinery control systems, for greater efficiency and safety or for unmanned operation as mentioned above is also a priority in private industry, particularly the manufacturing sector. The key feature is reduced cost of operation and greater safety.

REFERENCES:
1. http://www.marotta.com/
2. http://www.tycovalves-na.com/brand_literature_results.asp?Selection=Vanessa

KEYWORDS: MEMS, sensor, wireless, monitoring, control, condition-based maintenance, pressure

N04-221 TITLE: Acoustic, Thermal and Fire Insulation System

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS377 Amphibious Warfare

OBJECTIVE: Development of a new class of insulation to provide low-cost, light-weight, cost-effective insulation system that combines an improved acoustic performance with the required thermal, smoke, toxicity and fire barrier performance.

DESCRIPTION: Shipboard flight operations on the LHA(R) are expected to generate a high noise environment both above and below the flight deck well in excess of Navy's stated objective of less than 84 dBA at watchstander stations. The LHA(R) will be deployed with the Joint Strike Fighter (JSF), which replaces the AV-8B Harrier. The JSF will generate noise levels approximately 10 dB higher than the Harrier in spaces immediately below the LHA(R) flight deck (02 Level). The projected high noise environment, estimated to be 92-96 dBA based on aircraft carrier operations with current fixed-wing aircraft, will require additional broadband noise reduction (32 Hz-10kHz). These airborne noise levels are well above hearing protection criteria and space utilization criteria. OPNAV Instruction 5100.19D (Occupational Health Requirements) stipulates that new ship designs incorporate low noise emitting equipment and acoustical treatment so that the equivalent noise level at watchstander stations is less than 84 dBA under full power operating conditions where economically and technologically feasible. Passive noise reduction treatments are most effective above 1000 Hz (i.e. high frequency), and will compliment Active Noise Reduction (ANR), which are most effective below 1000 Hz. Current state-of-the-art materials do not provide broadband noise reduction without significant weight (3 lb/ft2) and space penalties. The solution proposed should provide be able to provide the needed noise control with the ease of installation, and the added benefit of thermal and fire protection.

A successful development would be expected to demonstrate the standard acoustic properties of transmission loss and absorptive characteristics using ASTM E 90-02 and ASTM C 423-02 as well as demonstrating the following characteristics: low smoke, thermal barrier, and condensation barrier. Standard tests are ASTM E-84 (Flame Spread and smoke); ASTM D-3359, Cross Hatch Adhesion; ASTM; D-882 Tensile Strength/Elongation; and pH. Applicable acoustic design parameters can be found in SNAME 3-37.

PHASE I: Demonstrate the feasibility of an acoustic and thermal insulation system that meets or exceeds current insulation systems. Provide concept validation plan and develop key component technological milestones.

PHASE II: Design, develop, and demonstrate a prototype insulation system for shipboard application. Predict the acoustic performance of the insulation system and validate the results using the validation plan provided in Phase I. In a laboratory environment demonstrate the capabilities of the proposed insulation system.

PHASE III: Design and fabricate full scale production insulation system for shipboard application. Thickness requirements and types of materials to be produced will be determined by Phase II results and funding availability. Shipboard installations will be measured in underway testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology will benefit the commercial maritime industry and the building construction industry. The commercial maritime industry has stringent requirements for noise and fire control and a need for multi-functional coatings.

REFERENCES:

1. See "Landing on the Roof" K. Yankaskas http://chppm-www.apgea.army.mil/imnc/Hearing_Conservation/HC_Presentations.html (25 April Session, Aircraft Carrier Noise).

2. K. Yankaskas, S. Fast "CVN Flight Operations: Crossing the Aircraft/Ship Interface", Naval Engineers Journal P347-357, Vol. 111 No. 3, May 1999.

3. K. Yankaskas, M Shaw "Landing on the Roof: CVN Noise", Naval Engineers Journal P23-34, July 1999.

4. MIL A23054, Type I Fiberglass Insulation

5. MIL I22023, Type II Fiberglass Insulation

6. DoDI 24688, Type I Polyimide Foam

7. "Design Guide for Shipboard Noise Control," Technical and Research Bulletin 3-37, Society of Naval Architects and Marine Engineers, 1983.

KEYWORDS: Acoustic insulation, acoustic absorption, thermal barrier, noise control.

N04-222 TITLE: Active Noise Reduction Technology

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS377 Amphibious Warfare Program Office

OBJECTIVE: Develop an active noise reduction system that will provide a quieter operational environment aboard surface ships.

DESCRIPTION: Shipboard flight operations on the LHA(R) are expected to generate a high noise environment both above and below the flight deck well in excess of Navy's stated objective of less than 84 dBA at watchstander stations. The LHA(R) will be deployed with the Joint Strike Fighter (JSF), which replaces the AV-8B Harrier. The JSF will generate noise levels approximately 10 dB higher than the Harrier in spaces immediately below the LHA(R) flight deck (02 Level). The projected high noise environment, estimated to be 92-96 dBA based on aircraft carrier operations with current fixed-wing aircraft, will require additional noise reduction in the low frequency bands (less than 1000 Hz). Active Noise Reduction (ANR) is most effective below 1000 Hz. These airborne noise levels are well above hearing protection criteria and space utilization criteria. OPNAV Instruction 5100.19D (Occupational Health Requirements) stipulates that new ship designs incorporate low noise emitting equipment and acoustical treatment so that the equivalent noise level at watchstander stations is less than 84 dBA under full power operating conditions where economically and technologically feasible. Current state-of-the-art materials do not perform well at low frequencies.

PHASE I: Demonstrate the feasibility of ANR at low frequency bands. Provide a preliminary design for an area ANR system for a manned space. The ANR concept design should address the anticipated system components and the associated ANR algorithms and powering requirements. The concept design should address the anticipated frequency coverage and the anticipated amount of noise reductions. Provide concept validation plan and develop key component technological milestones.

PHASE II: Design, develop and demonstrate a prototype ANR sub-system for shipboard noise mitigation. Using the validation plan developed in Phase I, demonstrate the ability to provide uniform ANR coverage within the targeted space.

PHASE III: Design and fabricate full scale system for shipboard application meeting the above requirements. Hardware requirements and types of materials to be produced will be determined by Phase II results.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology will benefit the commercial maritime industry and the building construction industry which have similar needs for noise control, particularly with diesel engines and in the vicinity of airport locations.

REFERENCES:

1. See "Landing on the Roof" K. Yankaskas http://chppm-www.apgea.army.mil/imnc/Hearing_Conservation/HC_Presentations.html (25 April Session, Aircraft Carrier Noise).

2. K. Yankaskas, S. Fast "CVN Flight Operations: Crossing the Aircraft/Ship Interface", Naval Engineers Journal P347-357, Vol. 111 No. 3, May 1999.

3. K. Yankaskas, M Shaw "Landing on the Roof: CVN Noise", Naval Engineers Journal P23-34, July 1999.


KEYWORDS: Active noise reduction (ANR), Active Noise Cancellation (ANC), noise control,

N04-223 TITLE: Total Ship Computing Environment Infrastructure (TSCE-I) Hardware and Software Technology

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop and demonstrate improved component hardware and software technology compatible with and beneficial to combat systems based upon a Total Ship Computing Environment (TSCE).

DESCRIPTION: The Naval Industrial community and government personnel have identified the need for the identification and development of new and "breakthrough" component hardware and software technology improvements to combat systems based upon a Total Ship Computing Environment (TSCE). Of particular interest are initiative directed toward providing products consistent with a TSCE architecture that would be available for use within the next 4 years. All component hardware and software technologies proposed should have a dual-use nature in order to reduce and minimize life cycle cost to the Navy. Products with benefit to other DoD programs would be beneficial to promote commonality. All component technologies should be consistent with the Navy proposed Open Architecture Computing Environment guidelines (when applicable).
Proposals under this topic must address at least one of the following research areas:

1: Component Hardware Technology
- COTS (commercial off the shelf) computer or printer environmental protection
- Positive security assurance
- Edge/Adaptation processors for connection of legacy systems to TSECI
- Improved graphical displays

2: Component Software Technology
- Improved methods for database management
- Internet software for tactical purposes
- Secured enterprise computing
- Multi-level secure networking
- Small, low cost peripheral data collection and legacy system interface
- Low-band application teleconferencing
- Weapons system software safety assurance for applications using COTS software
- Improved data publishing services
- Open application interfaces for measuring application satisfaction/performance
- User interface mark-up language (UIML) tools

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 military and commercial industries.

Proposals should indicate which areas are being addressed. Awards are planned to be made to the highest rated proposals overall and not set aside within each research area.

Teaming with the ship system integrator industry to form integrated project execution and implementation teams will improve transition potential and is strongly encouraged.

PHASE I: Demonstrate the feasibility of the improvement being developed and detail the measures of effectiveness that will be utilized to determine level of component improvement(s). Include a Return-On-Investment (ROI) market analysis for industry implementation and close collaboration with a shipyard customer to validate feasibility and marketability.

PHASE II: Develop and fabricate a working prototype production product to demonstrate its performance characteristics. Working with the Navy and the established industry partners, define the demonstration environment and develop an associated test plan. Conduct bench scale laboratory testing as necessary as a means of performance validation.

PHASE III: Working with the Navy and Industry, finalize and validate the component technologies by way of application to the DD(X) combat systems as installed in future ship construction.

PRIVATE SECTOR COMMERCIAL POTENTIAL:  This concept is applicable to commercial electronic systems with life cycles similar to military electronic systems i.e. long lifetimes, frequent technology refresh cycles, and frequent service.  The component technologies will benefit enterprise computer software and hardware products, with wide applicability to enterprise computing, data centers, Internet Service Providers, and Independent Software Vendors.


REFERENCES:
Representative Platform Application Information
1. http://peoships.crane.navy.mil/ddx/
2. http://www.naval-technology.com/projects/dd21/
3. http://www.raytheon.com/products/dd_x/multimedia.html
4. http://www.globalsecurity.org/military/systems/ship/dd-x.htm

Open Architecture and Combat System Information
5. http://www.geia.org/dsp2003/2003_Symposium/6MarAM/dodit(Strei).pdf
6. http://www.nationaldefensemagazine.org/article.cfm?Id=1099
7. http://www.dtic.mil/ndia/2002systems/hartwig3a1.pdf


KEYWORDS: hardware; TSCE; shock; environmental; protection; COTS

N04-224 TITLE: Elimination of Wood Dunnage in Trucks, Railcars, ISO Containers and Combat Logistics Force (CLF) Ship Cargo Holds

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE:  To reduce the huge Total Ownership Cost (TOC) associated with blocking and bracing ordnance loads for intra-station and over-the-road land transportation and stowage aboard CLF ships.  The cost, in materials and labor, to procure lumber and associated supplies, install dunnage in accordance with regulations, unpack dunnage at destination, and then dispose of retrograde waste, will be eliminated.

DESCRIPTION:  This effort would investigate the suitability to develop solutions to satisfy military specifications that dictate the requirements for truck, ISO and rail loading of ordnance, inert weapons and other heavy outsized cargo. Potential solutions include but are not limited to "air bags", collapsible metal stanchions that require little, if any, ship/deck alterations or any other innovative techniques.  Any potential solution must eliminate the costly and complex wood blocking and bracing now called out by Military Standards (MILSTDs) for land transportation of Navy ordnance and cargo. (see references below for details). A reusable versus disposable solution analysis should be considered as part of the effort.

If a metal dunnage system is proposed as a solution for CLF ship stowage, the design must be a direct replacement for and fit into the existing legacy CLF fleet ordnance cargo hold track systems and minimize ship alterations (SHIPALTS).

PHASE I: Analysis of Military unique requirements, study and limited test and evaluation of commercial airbags, collapsible metal stanchions, or other innovative techniques. Conceptual designs for ruggedized systems for intermodal shipping as well as for CLF ships.

PHASE II: Produce a limited number of test samples and perform validations testing, first intra-station and secondly between weapons stations and load-out facilities. Analyze results and prepare final designs.

PHASE III: Produce and qualify the proposed designs.

PRIVATE SECTOR COMMERCIAL: For land transportation, commercial truck and rail industry crossover use would by very feasible since these systems would improve commercial highway and rail safety, particularly with heavy items, since they would reduce shifted load rollovers. Additionally, the cost associated with both the material and labor required for wooden dunnage would be significantly reduced.

REFERENCES:
1. MILSTD 1320 - Truckloading of Ammunition and Hazardous Material

2. MILSTD 1325 - Railcar Loading of Hazardous Materials

3. MILSTD 1386 - Loading of Hazardous Materials in MILVAN Containers

4. NAVSEA Ordnance Pamphlet 3206, Volume 1, Chapter 5, Dunnage Systems

KEYWORDS: Wood dunnage, ordnance, airbags, transportation, blocking and bracing, retrograde, metal dunnage system, CLF ship cargo holds, stanchions, blocking and bracing labor, retrograde scrap material

N04-225 TITLE: Stable Platform Module for Ships

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop and demonstrate a stable platform module concept as an automated ship system for reliable launch and recovery of fixed wing Unmanned Aerial Vehicles (UAVs) and rotary wing Vertical Take-off Unmanned Aerial Vehicles (VTUAVs) in a wide range of sea conditions. The concept should also be adaptable for other applications such as transfers of men, material and operational payloads at sea. Additionally, consider mounting equipment types on the stable platform module for which operation is significantly enhanced by stabilization. The stable platform module concept should be compatible to a variety of hull types and sizes, especially small deck Navy ships and commercial ship designs as well. The module should have minimal ship design impact and provide stability at higher ship speeds in a variety of sea states (e. g. Sea State to 4 or 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. Commercial ships will also have need of similar capabilities to avoid hazards to navigation with an over the horizon viewing capability. The majority of existing and projected future UAVs and VTUAVs are difficult to operate from a Navy ship, especially the smaller ships of increasing interest for littoral warfare operations. To enable this capability, the Navy is investing significantly in the development of either vertical take-off UAVs or disposable UAVs. Development of a stable flight deck environment module will also enhance VTUAV and UAV operational success.

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. Consideration of network centric warfare concepts is also necessary to ensure that situational awareness is enhanced. Ships using UAV and VTUAV assets can provide location of contacts to other ships in the area, thereby sharing a common air and surface picture.

This proposed stable flight deck system shall provide an innovative approach to recover and positively secure multiple types of UAVs and VTUAVs 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 VTUAVs with minimum risk to the airframe, ship, or shipboard personnel.

This system must 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 and VTUAVs to preserve performance and certification and promote use with multiple and varied unmanned systems. 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, modular, stable flight deck concept for safe recovery of multiple types of fixed-wing UAVs and VTUAVs on Navy surface combatants with minimal ship design impact. Develop a concept of operations and projected capabilities (applicable UAVs and VTUAVs), 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 stable flight deck system developed in Phase I. Demonstrate the operation of the system in recovering at least two types of fixed-wing UAVs and a VTUAV of relevance to the Navy in controlled sea-based testing. Demonstrate operation in a variety of scenarios simulating Navy or commercial ship missions. 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 on a Navy platform. 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: At-sea transfer is a long-standing problem, especially in high seas. Control of the collision is essential to avoid or minimize damage to ships or to the cargo, personnel or vehicles being transferred to the ship. Vertical take-off and landing systems such as tilt-wing and rotary-wing systems have been developed for UAV use to alleviate this at-sea transfer problem. Delivery and recovery of crew members to ships at sea, or to off shore oil platforms. 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: Stable Sea Platforms, At-Sea Transfer, Fixed-Wing, Unmanned Aerial Vehicle (UAV), Launch, Recovery, Ship interface

N04-226 TITLE: Large Format Monolithic CCD Camera

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop a large format CCD camera capable of imaging large areas quickly on a single detector. A camera of this type can be used in a ground-based astrometric telescope to improve the celestial reference frame; this is needed to meet increasingly stringent requirements in navigation and targeting.

DESCRIPTION: The Navy and DoD rely on the celestial reference frame for many purposes. Satellite attitude determination, payload calibration, payload pointing, in-course missile adjustments, and space surveillance all depend on the celestial reference frame, especially accurate star positions (astrometry) used as fiducial points. To date, the best source of astrometry has come from the Hipparcos space mission flown in the early 1990s, whose positional accuracies in 2004 are ~15 to 20 milliarcseconds (mas) but deteriorating at a rate of 1.5 mas per year due to inaccurate knowledge in the stars' motions. As error budgets on projects shrink, the portion of the error budget allotted for astrometry tightens. Star tracker manufacturers typically allocate 10% of an error budget to astrometry; hence, if a star tracker has a 100 mas requirement, 10 mas star positions are needed. In the foreseeable future, the astrometric accuracies will not meet requirements; only new, improved observations can correct this.

A large-format CCD camera is needed in order to observe large portions of the sky in a single frame; previously this was done using large photographic glass plates. A monolithic device is necessary for adequate reductions of image scale, rotation, tilt, etc. for each frame. A camera of this type can be used on existing ground-based telescopes optimized for wide-field astrometry or used on planned, future instruments.

Current commercial CCDs are too small. An R&D effort is needed because a simple scaling of current procedures cannot produce a full wafer-size detector with acceptable cosmetic quality due to extremely low yield. As the silicon semiconductor industry has matured new process technologies have evolved. These include High-K dielectrics, shallow trench isolation, chem-mechanical processing, mixing and matching scanner and stepper photolithography, and wafer fusion. Innovative incorporation of these new tools for CCD manufacture can yield larger area, improved optical sensitivity, higher resolution, and increased dynamic range at acceptable prices.

In order to test any such new detector on the sky, we intend to utilize existing astrometric telescopes with a large field of view. For this reason, the prototype detector should have the following characteristics:

- a large, single CCD of up to the limit of a 150 mm wafer;
- pixel size of 8-10 microns, leading to 100 to 150 million pixels;
- at least 14-bit dynamic range;
- a charge transfer efficiency of greater than or equal to .99999.

For the R&D effort, the following trade options could be investigated:

- fast read-out (<10 sec) vs. number and type of amplifiers;
- operating temperature vs. noise limit (10 electrons RMS goal);
- thick or thinned devices vs. geometric stability;
- CCD v. CMOS options
- all the above vs. adequate yield and cosmetic quality.

PHASE I: Perform an initial feasibility study. This includes design trade studies such as technology requirements, performance studies, yield studies, etc. needed for maximum optical performance and manufacturability. If feasibility is demonstrated, then a preliminary design for the detector will be produced. A reasonable approach to producing a prototype device will be specified.

PHASE II: Design, fabricate, and demonstrate a prototype detector with the required specifications. A final design will be produced following review of the Phase I work. The detector will be fabricated and demonstrated to show it can meet the performance goals specified in the Description section of this document. The goal is to produce a working device with only about 0.1% bad columns and about 0.1% hot or dark pixels.

PHASE III: Transition this R&D effort into a commercially viable product, complete with integration into a cooled camera system. In addition to the primary goals mentioned above, increase of the yield and thinning of some of the detectors for enhanced quantum efficiency will make the manufacturing of these devices more commercially viable.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The continuing development of large-format electronic detectors should have many commercial applications. These include markets in crime fighting, intruder detection systems, and medical imaging. A large format CCD will also allow the replacement of the professional, "mid-size" photographic film. The size of the focal planes of other telescopes for general astronomy and space surveillance systems are getting larger as well, demanding such large size detectors.

N04-227 TITLE: <u>Integration and Optimization of Hydrogen Production with Ocean Thermal Energy Conversion Technology in Offshore Floating Platforms</u>

TECHNOLOGY AREAS: Information Systems, Materials/Processes

OBJECTIVE: Develop a conceptual design integrating hydrogen production with ocean thermal energy conversion (OTEC) technology on Tropical Ocean floating platforms to serve as fuel depots for future hydrogen powered Navy vessels as well as to supply civilian populations.

DESCRIPTION: Hydrogen production and liquefaction using OTEC was proposed (but not implemented) by Lockheed more than two decades ago to supply transportation fuel to southern California. Since then, advances in OTEC process design, materials and systems engineering indicate that OTEC/hydrogen can be synergistically integrated to minimize production costs. Such a system would provide access to the largest renewable energy resource in the world and thereby potentially end dependence on imported fossil fuel with substantial environmental benefits. This effort will adapt, upscale, and integrate existing technologies in floating platform and cold water pipe design, OTEC systems, and hydrogen production and storage.

PHASE I: Provide a conceptual design integrating a floating platform with an OTEC system to produce and store hydrogen using state-of-the-art computer modeling techniques and established ocean engineering principles and practices. Evaluate the design to determine the technical and economic feasibility of the concept.

PHASE II: Develop a preliminary engineering design of the conceptual design from Phase I sufficient to provide construction cost estimates for potential funding agencies and/or investors.

PHASE III: Develop an OTEC/hydrogen plant design and actualize a floating fuel depot in the tropical ocean for US Navy use and/or to supply commercially viable liquid hydrogen for civilian use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Development of OTEC/hydrogen production platforms would benefit the marine construction sector and provide access to the largest renewable energy resource in the world. Commercial potential is comparable to the present fossil fuel industry.

REFERENCE:
1. Avery, W. and Wu, C., "Renewable Energy from the Ocean - a Guide to OTEC", Oxford University Press, New York, 1994.

KEYWORDS: Hydrogen; OTEC; renewable; green power; fuel cells

N04-228 TITLE: Development of a Sensor System for Reliable, Automated Detection of Surfaced Swimmers

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: Strategic Systems Programs

OBJECTIVE: Develop a low-cost system for reliable, automated detection of unauthorized swimmers transiting on the surface of the water. The detection system should be capable of reliable operation and performance in low light conditions and in a variety of environmental conditions.

DESCRIPTION: Traditional methods of surfaced swimmer detection do not always provide reliable performance, particularly in choppy water and low light conditions (e.g., dense fog, night). More reliable methods are desirable for ports that are focusing on providing improved physical security for critical assets and infrastructure. Since this capability does not exist, science and technology is required to develop a new, innovative approach.

Desirable characteristics of a notional surfaced swimmer detection system include:

• Greater than 90% probability of detection of surfaced swimmers (bare skin or wet suit) at ranges in excess of 500 yards
• Detection and classification algorithms that can provide automatic classification and alert within 100-150 yards of initial detection
• Low false alarm rate (preferably no more than 1 every 6 hours)
• Reliable, 24/7 operation in all weather conditions, including:

o low visibility conditions
o moderate to heavy surface chop conditions
o wide spectrum of water surface temperatures
• Provide real-time position data on all tracked contacts
• Ability to handle multiple, simultaneous tracks
• Output compatibility with an open architecture command/control/communications/display (C3D) system

PHASE I: Establish performance criteria and measures of effectiveness, conduct an initial evaluation of available sensor technologies and downselect system concepts.

PHASE II: Design and develop the detection system concept(s) that was selected in Phase I. Generate and validate system performance predictions and develop cost estimates for fielding of the system(s) proposed. Provide system-level design drawings. Produce and demonstrate a working prototype of the system.

PHASE III: Generate and provide test report. Generate detailed system- and component-level design drawings. The system will transition to Strategic Systems Programs (SSP) for engineering development and eventual use in security systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A reliable swimmer detection system would likely have broad application in the protection of other government and commercial ports and port assets.

REFERENCES:
1. Title: Non-Lethal Swimmer Neutralization Study
Classification: UNCLAS Corporate Authors: Applied Research Laboratories--The University of Texas (ARL-UT)
Personal Authors: Rehn, Karl W.; Riggs, Penny K.
Report Date: MAY 2002
Final report under contract N00039-96-D-0051

KEYWORDS: swimmer; detection; security; automated; physical; surfaced

N04-229 TITLE: <u>Secure Communications in a Noisy Environment</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Strategic Systems Programs

OBJECTIVE: Develop a communication system from inner element of gimbaled system to external computer that is extremely reliable over long periods of time.

DESCRIPTION: A primary deficiency inherent in gimbaled systems is intermittent platform (inner element) communication failures caused by debris or moisture on the slip rings. A creative approach is needed to make this communication link reliable and secure. Develop a secure and highly reliable methodology for transmitting data from/to the inertial navigation system platform to the external processor. This can be accomplished by transmission over/through the slip rings, through the structure, wireless, through fiber optics, or other means as long as EMI and reliability standards are met. Although the data rates are not high, they must be reliable because the system does not tolerate multiple/repeated failure to receive/send data words. The reliability problems of slip rings have existed for well over 60 years. New, innovative science & technology approaches are needed to solve these problems.

PHASE I: Identify a detailed trade space along with conceptual design solutions for the data transmission alternative(s). Provide a plan for development and of prototype unit(s).

PHASE II: Build a prototype. Conduct a demonstration of this capability from an aluminum encapsulated rotating device to a rigid frame in the presence of noise which can be varied during test process.

PHASE III: Transition the technology to Strategic Systems Programs (SP24). Investigate applications of this device in the manufacturing, transportation and propulsion industries. Investigate methods for low cost production of this device(s).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial applications whereby information must be transmitted from rotating machinery to a rigid base. Examples: manufacturing robotics, transportation & propulsion devices.

REFERENCES:
1. Gerry Christensen, Robert Duncan, & Paul G. Florack , (Wireless Intelligent Networking)
2. Adrian Perrig & J.D. Tygar, (Secure Broadcast Communication)
3. DOE 5300.2D, TEMPEST, August 30, 1993

KEYWORDS: communication; moisture; transmission; reliable; data; wireless

N04-230 TITLE: Data Fusion for Geophysical Aided Navigation Technologies

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Strategic Systems Programs

OBJECTIVE: Leverage current innovative methods in data-fusion, signal processing and neural networks to develop a navigation technology using geophysical data e.g.: fathometer, gravimeters, gradiometers, magnetometers that will optimize Inertial Navigation System (INS) endurance and accuracy.

DESCRIPTION: The Submersible Ship Ballistic Nuclear (SSBN) submarine programs depend on optimal navigation performance to ensure mission success e.g.: SSBNs need accurate navigation to achieve required missile accuracy, Submersible Ship Guided Nuclear (SSGN) submarines need accurate navigation for Special Operating Force (SOF) delivery and recovery. Although the different platforms have different requirements for the inertial navigator, both the SSBN and SSGN platforms as well as Attack submarine platforms need to cost effectively optimize their navigation solution. Geophysical navigation is a proven technology for improving INS accuracy and endurance. This topic seeks innovative technologies that utilize recent advances in a variety of areas such as particle filters, data-fusion, signal processing, and neural networks to develop methods that will couple existing ship INS data with independent geophysical sensors data to provide a sustained high accuracy navigation solution. Integrating information from these different sensors and applying that information to improve navigation has never been done before. This will require innovative R&D to develop the software and algorithms needed to achieve the accuracies required.

PHASE I: Develop the algorithm mechanization for combining various geophysical sensor measurements that fuse with INS, position velocity, and heading information to provide an improved navigation solution in terms of endurance and accuracy.

PHASE II: Implement the Proof Of Concept algorithm mechanization developed in Phase I. Provide deliverable demonstration code that can be implemented on a test vessel. Evaluate and test the resulting performance in both a lab environment and at-sea (assume Strategic Systems Programs (SSP) will provide USNS Waters for at-sea test.)

PHASE III: Productize the successfully demonstrated INS/Geophysical data-fusion software module The productization approach shall meet all Navy Strategic Systems Projects Alteration (SPALT) requirements necessary to deliver the software to the fleet. This will require working with current prime contractors in ensuring that software requirements are met and that the software is compatible with existing inertial navigation systems software. Additionally, broader use commercialization and militarization options will be identified in this phase.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advancements in data fusion technology will benefit the commercial navigation industry and the hydrocarbon and mineral exploration industry. The railroad industry is searching for new navigation technologies to provide continuous precise train location with and without GPS. In particular, Lockheed Martin has developed a first generation train Location Determination System (LDS) based on fusing GPS, INS, tachometer and track data base information to ensure precise train location is maintained when operating in tunnels, areas of dense foliage and other GPS degraded conditions. The mineral and hydrocarbon industry are continually pursuing new technologies to improve their ability to precisely detect the location of hydrocarbon and mineral deposits. Current approaches are based on fusing seismic, gravity, magnetics and other sensors. The pursuit of new data fusion technologies proposed for this effort will have applicability to these and other commercial data fusion applications.

REFERENCES:
1. Pitman, G.R., "Inertial Guidance," Wiley
2. Tetley, Laurie, " Electronic Navigation Systems", Science & Technology Books, 3rd Edition
3. Hall, D.L..Llinas,J.: "Handbook Of Multisensor Data Fusion,"The Electrical Engineering and Applied Signal Processing Series, CRC Press
4. "2000 CJCS Master Positioning Navigation And Timing Plan", Chairman Of The Joint Chief Of Staff Instruction, 6/2000

KEYWORDS: navigation; bathymetry; navigation warfare; gravimetry; data fusion; GPS

N04-231 TITLE: Display and Visualization of Movement Predictions for Ground Vehicles

TECHNOLOGY AREAS: Information Systems, Weapons

ACQUISITION PROGRAM: Surface Ship Cruise Missile Weapon Systems

OBJECTIVE: Develop innovative technologies that will optimize the display of information to enable a single operator to manage the tracking of multiple moving ground vehicles.

DESCRIPTION: New algorithms and display methods are required to assist the operator of the Tactical Tomahawk Weapon Control System (TTWCS) in visualizing the probable future movement of multiple ground vehicles. Relevant operational factors to consider include geographical location, terrain, weather, ground vehicle movement characteristics, ground vehicle tactics, and the observed locations of the vehicle to bound the movement in given time intervals. The projected geographical area where the vehicle may be located will be used for searching and locating ground vehicles and for avoiding re-locatable threats. The projected future movement of the vehicle will also be used to assist the operator in planning a loiter path for a surveillance asset or weapon. Scenarios involving multiple ground vehicles complicate the visual picture. The visualization method developed should support the operator in analysis of the movement prediction algorithms results, based on probability of movement, to further reduce the area where the ground vehicle could be located. That information could then be used for performing a search of the area to locate the vehicle.

PHASE I: Develop an innovative technology concept to assist an operator in visualizing projected future movement of a ground vehicle. Demonstrate the technical merit of the proposed solution.

PHASE II: Implement and demonstrate a prototype of the innovations developed in Phase I.

PHASE III: Mature the prototype capability for use in the TTWCS software architecture in a major upgrade scheduled to be done in FY06.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There has been research into technologies for dynamic time travel prediction and prediction of vehicle behavior for the Department of Transportation. These technologies have potential for commercial application in the automobile industry. The concepts developed under this SBIR topic could have some potential application in the commercial automobile industry.

REFERENCES:
1. Johnson, Bruce. "Affordable Moving Surface Target Engagement (AMSTE)." Brief DARPA Tech., June 1999.
2. Chen, Mei. "Dynamic Freeway Travel Prediction Using Probe Vehicle Data: Link-Based vs. Path-Based." National Center for Transportation and Industrial Productivity, TRB Paper No. 01-2887.

KEYWORDS: Algorithm; Display; Visualization; Tracking; Movement Prediction; Mathematical Optimization

N04-232 TITLE: Altitude, Latitude, and Longitude Reference Database of Man-Made Obstacles

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 209

OBJECTIVE: Develop innovative technologies to collect and process an obstacle database indexed by latitude, longitude, and world geodetic system (WGS-84) suitable for military operations.

DESCRIPTION: The embedded Terrain Awareness Warning System (eTAWS) contains a digital terrain elevation database that provides protection against flying into rising terrain. However, it does not provide similar information on man-made objects such as buildings, towers, and wires. Position and height placement of man-made objects on a world grid will require the innovative use of geodetic survey information, which is a rapidly changing science itself. The acquisition and updating of man-made obstacle data, as well as management of the database to correlate with geodetic surveys, will be a technological challenge.

Innovative technologies are sought that will provide a latitude and longitude reference database of man-made obstacles referenced to the WGS-84 coordinate system. Technical challenges that should be considered are:

- Data resolution
- Vertical and horizontal accuracy
- Data storage considerations
- Coverage of area
- Methods of maintenance and updates, including frequency
- Collection and source methodology
- Traceability, quality assurance, error, and system integrity methodology
- Ease of interface with U.S. military mission planning systems

Tradeoffs among minimum heights, data resolution, and storage requirements should also be considered. A minimum obstacle height of 50 feet above ground level (AGL) is desired; 200 feet should be considered as a requirement.

PHASE I: Design and develop an innovative obstacle collection and processing method for database concept. Demonstrate the feasibility of the proposed design to meet the technical challenges defined above.

PHASE II: Develop, demonstrate, and validate the prototype obstacle database. Demonstrate the capability of updating the database with new information. The demonstration area should be a minimum of 1,000 square nautical miles. The specific location will be determined at award of Phase II.

PHASE III: Integrate the prototype system with a U.S. military mission planning system and test it in a U.S. Navy aircraft platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is a high likelihood of commercial aircraft desiring or requiring obstacle databases in the near future as reliance on GPS navigation becomes more prevalent. An obstacle database that can be integrated with ease into various aircraft systems will be of great potential value on the world market.

REFERENCES:
1. 2002 Naval-Industry R&D Partnership Conference; Assault System Technology Needs/Issues; http://www.naval-industrypartners.com/2002/assault_technology_needs1.htm
2. RTCA DO-276; User Requirements for Terrain and Obstacle Data.

KEYWORDS: Obstacle; Database; Terrain; eTAWS; WGS-84; Mean Sea Level

N04-233 TITLE: Object/Target Discrimination, Recognition, and Identification

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Joint Strike Fighter (JSF); PMA-272, Advanced Tactical Aircraft Protection

OBJECTIVE: Develop a real-time capability, using existing sensor data that discriminates between decoys and objects/targets to perform object/target recognition and object/target identification (caller identification (CID) and combat identification).

DESCRIPTION: This technology will increase the performance throughput and affordability of naval organic manned and unmanned systems. It will enable automated onboard surveillance, reconnaissance, and strike data processing. This could include target discrimination/identification, onboard platform decision-making, and operator/user workload reduction. The technology should not be restricted to limited angles of approach to the objects/targets. The computational requirements for this system must be relatively small (performing the computation quickly, requiring relatively small memory for any object/target database, etc). At a minimum, these system functions should be demonstrated on a standard laptop computer. It is highly desirable that the process be highly independent of the camera range or orientation relative to the object/target so that the system can be used in global positioning system (GPS)-denied regions. One of the long-term objectives is to reduce operator workload and/or eliminate operator involvement. Another of the long-term objectives should be a highly compressed representation of the object/target to enable sharing of the object/target representation with other on-board systems, with off-board air platforms (manned and unmanned), as well as with ship based/ground based systems (e.g., tactical communication systems (TCS)). This feature is required to reduce the bandwidth needed for object/target transmissions and to enable use of existing processing and transmission (data link) hardware.

PHASE I: Determine the feasibility of a deterministic (rather than a heuristic-based) real-time processing capability to accomplish computer discrimination, recognition, and identification. Demonstrate the basic algorithm capability to discriminate between decoys and objects/targets.

PHASE II: Develop, demonstrate, and validate an algorithm and prototype system that can discriminate between decoys and objects/targets utilizing minimal sensor data. The prototype should not be restricted to limited angles of approach to the objects/targets. It should demonstrate relatively small computational requirements of the algorithm and developmental system and a highly compressed representation of the object/target to enable sharing of this information and hence reduction of the required bandwidth for the object/target transmissions. The algorithm and prototype system for the object discrimination, recognition and identification system should enable automated onboard surveillance and reconnaissance data processing.

PHASE III: Transition the system to appropriate intelligence, surveillance, reconnaissance and strike manned, unmanned, unattended, autonomous airborne and/or ground platforms. Transition a complete object discrimination, recognition and identification software system or a set of object discrimination, recognition and identification software modules/tools for incorporation into existing/legacy systems and platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The facility protection capability will be beneficial to the commercial security sector. The facilities protection and identification capabilities will be beneficial to Homeland Security as well as force protection in hostile areas, and the identification capabilities will be beneficial to rescue services.

KEYWORDS: Real-Time Image Processing; Decoy Discrimination; Object/Target Recognition and Identification; Non-Template Based Target Identification; Reduced Bandwidth; Camera Orientation Independence

N04-234 TITLE: Hypersonic Infrared Dome

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-265, F/A-18

OBJECTIVE: Design and develop an optically polished, tangent ogive, infrared-transmitting dome made of polycrystalline alumina or other material with thermal shock resistance, durability, and infrared bandpass similar to or greater than that of sapphire. When fitted with an appropriate nosetip, the dome should survive hypersonic flight (Mach 6 at 20 km altitude).

DESCRIPTION: Hemispheric infrared-transmitting domes are not capable of surviving the thermal shock associated with hypersonic flight. An aerodynamic shape, such as an ogive, with a durable material at the nose, could survive in hypersonic flight if the infrared-transparent material had at least as great a thermal shock resistance as sapphire. Infrared-transparent, polycrystalline alumina with thermal and mechanical properties similar to those of sapphire was demonstrated in 2003 [1-3]. The front of the dome will be left open for eventual attachment of a durable nosetip that will enable flight at hypersonic speeds.

Near-net-shape casting of infrared-transparent, polycrystalline alumina (or a superior material) should be in the form of a tangent ogive whose finished dimensions will be a base diameter of 130 mm, a thickness of 2 mm, and a height of 195 mm. The outside and inside of the dome should be ground and polished to an optical quality finish.

PHASE I: Demonstrate the feasibility of near-net-shape casting of polycrystalline alumina (or a material with similar or better thermal, mechanical, and infrared properties). The infrared transmittance of polished, flat witness samples should be within 2 percent of that of sapphire in the 3-5-µm wavelength region. Cast a subscale tangent ogive with a base diameter of 50 mm, a height of 50 mm, and a thickness of at least 2 mm. Determine the feasibility of optical polishing and figuring of the outside of the ogive. Develop a plan for how the inside of an ogive can be optically polished.

PHASE II: Demonstrate the optical polishing of the inside of the subscale ogive fabricated in Phase I. Cast three full-scale, near-net-shape, tangent ogive domes with a base diameter of 130 mm, a thickness of 2 mm, and a height of 195 mm. Develop methods for optical polishing of the outside and inside surfaces of the full scale dome and deliver two fully polished, full-scale domes. Provide measures of optical figure and surface quality.

PHASE III: Demonstrate commercial production capability for casting and polishing full-scale domes.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Optical quality polycrystalline alumina has commercial potential as the lamp element for high intensity automobile headlights.

REFERENCES:
1. Krell A., Blank, P., Ma, H., Hutzler, T., Van Bruggen, M. P. B., and Apetz, R. “Transparent Sintered Corundum with High Hardness and Strength.” J. Am. Ceram. Soc., 86, 2003, pp. 12-18.

2. Krell A., Blank, P., Ma, H., Hutzler, T., and Nebelung, M. “Processing of High-Density Submicrometer Al2O3 for New Applications.” J. Am. Ceram. Soc., 86, 2003, pp. 546-553.

3. Krell, A., Baur, G., and Dähne, C. “Transparent Sintered Sub-µm Al2O3 with IR Transmissivity Equal to Sapphire.” Proc. SPIE, Volume 5078, 2003.

KEYWORDS: Missile Dome; Infrared Dome; Hypersonic Missile; Polycrystalline Alumina; Polishing; Ceramic Fabrication

N04-235 TITLE: Portable Handheld Imaging Radar System Technology

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a portable, user-friendly, imaging radar capability with increased measurement sensitivity and rapid disposition during maintenance measurement operations.

DESCRIPTION: Multi-Service low-observable (LO) platforms that use special materials/structure to reduce their whole body signature require radar imaging verification equipment to ascertain potential degradation effects resulting from in-service damage and/or subsequent repairs. These LO platforms require robust handheld, highly portable verification equipment that is suitable for use in all types of field maintenance environments. The handheld radar imaging equipment must be capable of providing rapid decision support information to the operator.

Small portable synthetic aperture imaging radar systems are commercially available. These systems have limitations that are primarily due to antenna technology, the speed, stability and internal noise levels of the radio frequency (RF) segments of the radar, or combinations thereof. Each system has developed antenna technologies with different approaches. However, traditional antenna forms (for example, horns, slot antennas) are common. The inherent capability of the commercial instruments is such that a technique called "integration" is required to achieve maximum sensitivity. The integration technique compares multiple images to look for and eliminate noise in the image. The integration requires collecting several images from a single location. Currently, it is very difficult to collect images with a handheld instrument because of the time required for data collection and the weights/dynamic antenna movement involved in forming a synthetic aperture with adequate size and cross-range resolution.

In addition, if a portable handheld imaging radar were able to achieve both sensitivity and agility, the challenge of providing realistic accept/reject data (via computer image comparison or retrieval of archive 'golden' aircraft image data) must be resolved. No easy method of presenting decision support information to the operator of the radar exists. The operator is therefore completely reliant on judgment and experience to determine if a displayed image represents a good or bad portion of the aircraft requiring additional restoration/maintenance.

PHASE I: Conduct development efforts to identify and assess techniques to increase sensitivity and agility of handheld instruments including one or more of the following techniques and antenna design technologies or using other innovative techniques or portable imaging radar system design concepts:

- Decrease dependency on holding the radar motionless during data collection by using motion compensation, image registration, or other techniques.
- Decrease time required to collect data via increased RF electronic speed and/or decreased image post-processing times.
- Decrease potential radar image data inaccuracies introduced by various aiming, positioning, distance, and other deviations from known (computationally simple) straight paths.
- Provide methodologies of collecting, storing, retrieving, and presenting accept/reject data associated with any point on the aircraft outer mold line (OML) taken from any relevant angle in real time, synchronized with the agile movements of the handheld radar.
- Assess phased array antenna technology for application to portable imaging radar.

PHASE II: Develop, demonstrate, and validate prototype portable imaging radar technologies and techniques identified from the Phase I effort. Modification of existing handheld portable imaging radar systems or assembly of laboratory instrumentation and prototype devices will be acceptable as proof of concept.

PHASE III: Transition the innovative techniques/technologies to produce the robust handheld system that provides high-fidelity measurements and compactness. Handheld system must also be suitable for multi-Service (Army, Navy, and Air Force) field application as portable imaging radar support equipment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be used by the Department of Homeland Security to provide improved protection for commercial aircraft.

REFERENCES:
1. http://www.shmoo.com/mail/cypherpunks/jun99/msg00001.html
2. http://www.globalsecurity.org/military/library/budget/fy2001/dot-e/army/01comanche.html
3. http://www.f22fighter.com/AffordableStealth.pdf

KEYWORDS: Portable Imaging Radar; Sensitivity; Phased Array; Handheld; Low-Observable Platform; Synthetic Aperture Radar

CONTRACTUAL RESTRICTIONS:

1. Technical data/information developed as a result of the SBIR N04-235 contract award, or in any way related to this SBIR Must Not be discussed, offered or released to non-US personnel unless the SBIR related contract agreements are amended to reflect dual national or third country nationals participation. Each individual involved with this SBIR N04-235 must execute a Non-Disclosure Agreement (NDA) acknowledging the fact the data is limited to "US Eyes Only."
2. Dual National or Third country nationals Must Not have access to any technical data/information developed as a result of the SBIR N04-235 contract award unless specifically approved by written amendment under this SBIR contract agreement.
3. Commercialization of NDP/ITAR constrained developments/products resulting from SBIR N04-235 are limited to US use only and subject to US export controls.
4. Each individual involved (or associated) with the SBIR N04-235 phase II, must possess or be able to obtain a security clearance in accordance with the National Industrial Security Operating Manual (NISPOM). The level of clearance required will be driven by the Security Classification Guide (SCG) provided in conjunction with the Contract Security Classification Specification (DD254) issued at the SBIR contract award. The SCG will indicate the appropriate level of security classification for the technical data/information developed (or used) as a result of the SBIR contract.

N04-236 TITLE: Enhanced Data Link Performance in Multipath and Interference Environments

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-213, Air Traffic Control and Landing Systems

OBJECTIVE: Improve link robustness and reduce radiated power requirements for a data link between ships and aircraft in a multipath and interference environment.

DESCRIPTION: The performance of an ultrahigh frequency (UHF) data link between a ship at sea and an approaching aircraft is typically degraded by two mechanisms. One source of degradation is multipath both off the sea and off ship and aircraft structures. The second source is interference from in-band and out-of-band emitters, particularly on the ship. For a data link that is part of a ship's landing system such as the Joint Precision Approach and Landing System (JPALS), loss of signal strength caused by fading or loss of signal fidelity caused by interference may result in unwanted landing delays or serious accidents. The signal fading caused by multipath becomes more rapid as the aircraft nears the ship. Hence, the closer the aircraft is to landing, the more severe the multipath effects may become. With locations for antennas at a premium on both ships and aircraft, the challenge is to find a combination of transmission policy, antenna capability, and electronic processing capacity to mitigate data link degradation caused by multipath.

The performance of data links that are part of a ship's landing system such as JPALS require transmission, antenna, and/or electronic processes that are able to dramatically reduce instances of loss of signal strength caused by fading and/or loss of signal fidelity caused by interference. Antenna procedures must continue to perform in the presence of ship's motion and changing sea state. Antenna procedures on aircraft must continue to perform in the presence of the aircraft's motion and changes in weapon stores. Electronic cancellation processes must be able to perform over the extreme variations in interference power levels as well as respond to the rapidly changing interference background in both power level and frequency. Care must be taken that any combination of antenna and electronic processing result in a minimum of insertion loss as the data links are often required to support covert operations.

PHASE I: Identify and demonstrate new and innovative approaches to improving two-way data link propagation between ships and aircraft that will support the high level of message integrity required for aviation operations. This would support requirements of the data link to provide high data rates while providing a signal that is of very low power. The conceptual design hardware and algorithms should include such considerations as antenna technologies, antenna sitting, and processing techniques.

PHASE II: Prototype and demonstrate the selected approach. Generate and document algorithms. Prototyping should include options to integrate with suitable hardware for evaluation, including potential government furnished equipment (GFE).

PHASE III: Conduct appropriate testing of the solution and provide necessary support for testing by the Navy in an operationally relevant environment. Demonstrate a mature system in fielded platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Enhanced data link performance has immense potential military and commercial customers. The Joint Tactical Radio System (JTRS) can be expected to have several applications where increased reliability in interference and multipath occur. Cellular telephone companies are already looking at various techniques to improve system performance.

REFERENCES:
1. Final Draft, Operational Requirements Document (ORD), Joint Precision Approach and Landing System (JPALS), ACAT Level ID, USAF 002-94-1 (Unclassified).

2. Joint Precision Approach and Landing System (JPALS), Test and Evaluation Master Plan (Unclassified).

3. JPALS SRGPS Ship System Performance Specification.

KEYWORDS: Data Link; Multipath; Interference; Signal Fading; Antennas; JPALS

N04-237 TITLE: Mobile Shallow Water Antisubmarine Warfare (ASW) Target System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-264, Air ASW Systems

OBJECTIVE: Provide innovative, mobile shallow water ASW target capability for air platforms.

DESCRIPTION: ASW search and localization capability is needed in shallow water where deep water systems are limited. Technologies are sought that are capable of emulating active (low-frequency coherent and explosive echoes) and passive emissions of third world submarines. Other requirements are the ability to generate realistic echo returns when using sonobuoys and produce narrow and broadband passive signals to allow search and localization sensor validation, even in a cluttered shallow water environment. Proposed solutions should be usable independently as well as in concert with sonobuoys when the system is air deployed in a sonobuoy field. Proposed technology should be able to telemeter or store detection alerts, acoustic data, and self and target location information. It should be capable of being deployed from both air and surface platforms and should be mobile, traversing a pre-programmed or command activated course. The system should also be capable of operating in a countermeasure environment.

PHASE I: Develop a system concept and approach for the shallow water target system for ASW missions and identify the critical technologies required to implement the system. Conduct a system analysis to ensure that all technical capabilities satisfactorily meet operational objectives.

PHASE II: Develop the critical technologies identified in Phase I. Fabricate, test, and evaluate a stand-alone prototype of the system. Conduct a laboratory or field test if needed to establish the feasibility of the approach.

PHASE III: Optimize the system design based upon the test and evaluation results of Phase II. Fabricate prototype units and conduct at-sea tests with operational commands. Integrate the system into the air platform's missions and ensure compatibility with the avionics and platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Variants of the system could be used for bottom contour mapping, mine countermeasures, drug interdiction, oil exploration, and search and rescue operations.

REFERENCES:
1. Urick, R.I. Principles of Underwater Sound for Engineers. New York: McGraw-Hill Book Company. 1992.

KEYWORDS: Acoustic Source; Mobile Surveillance; Shallow Water; ASW; Remote Underwater Vehicle; Countermeasures

N04-238 TITLE: Cosite Interference Reduction for Electronic Attack Aircraft

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA-265 F/A-18 (EA-18) Program

OBJECTIVE: Develop innovative technologies that would reduce interference from tactical jamming systems to allow reliable, nondegraded communications during airborne jamming operations.

DESCRIPTION: The EA-6B Prowler aircraft's primary role is to protect Fleet surface units and strike aircraft by jamming enemy radar and communications. The high-power radio frequency (RF) jamming being carried on the aircraft is so near to the aircraft communications antenna that communications and identification, friend or foe (IFF) can be disrupted or severely degraded during combat. This presents an extreme safety hazard in that the aircraft cannot be warned of an imminent air threat and cannot identify itself to friendly forces. The EA-6B replacement, the EA-18G aircraft, is expected to suffer the effects to the same or greater degree.

New innovative technologies are sought to reduce the interference from the tactical jamming system and communication-jamming systems to the ultra-high-frequency (UHF) voice communication, Link 16, and IFF systems to allow reliable, nondegraded communications during airborne jamming operations. The interference reduction system must reduce interference energy prior to the victim receiver front end by 70 to 90 dB. Adaptive systems will require high-speed processing to operate with the frequency-hopping communication systems and the ability to operate on relatively high power levels. Considerations should be given to radar absorbing materials (RAM) to improve the RF isolation between the jamming and communication systems, antenna pattern management, frequency-agile filters, interference canceller, and signal processing.

PHASE I: Develop interference reduction concepts and demonstrate proof-of-concept and system effectiveness.

PHASE II: Develop, demonstrate, and validate the prototype system. Demonstration should include prototype capability with the actual jamming and communication systems.

PHASE III: Prepare a system for aircraft installation and flight test. The system must be packaged and qualified for the aircraft environment. Conduct and support ground, chamber, and flight tests to determine the systems potential for operational effectiveness and suitability and provide documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: With the growth of RF "wireless" devices, the potential for mutual interference increases. Solving the difficult problem of reducing the interference from a tactical jamming system would transfer to reducing interference between private and commercial telecommunication systems.

REFERENCES:

1. Chambers, D.S.G, Howett, D.W., and Streeter, R.D. "Removing cosite interference using tunable filter technology." Tactical Communications Cnference, 1992. Vol.1 Tactical Communications: 'Technology in Transition'., Proceedings of the. 28-30 April 1992. pages 261-270 vol.1. IEEE Catalog Number: 92TH0467-1.

2. Williman, G. and Rivingston, T. "A performance analysis of cosite filters in acollocated SINCGARS environment." Tactical Communications Conference, 1990. Vol. 1. Tactical Communications. 'Challenges of the 1990s'., Proceedings of the. 24-26 April 1990, pages 593-604. IEEE Catalog Number: 90TH0258-4.

3. Nolan, Troy C. and Stark, Wayne E. University of Michigan. "Mitigation of Cosite INterference in Nonlinear Receivers with MEMS Filters." IEEE. 2000. IBSN 0-7803-6512-6.


KEYWORDS: Airborne; Cosite; Interference; Isolation; Jamming; Radio Frequency

N04-239 TITLE: Advanced Ram Air Driven Power and Cooling Unit

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-234, EA-6B Program; PMA-265, FA-18 (EA-18G) Program

OBJECTIVE: Develop technology to utilize ducted ram air inside an aircraft pod for electrical power generation and equipment cooling through liquid heat exchange.

DESCRIPTION: Ram air turbines (RATs) provide primary electrical and/or hydraulic power for military airborne stores, such as electronic warfare jamming pods and refueling stores. In addition, RATs provide emergency electrical and/or hydraulic power for military and civilian aircraft. For military airborne stores (pods), the traditional method for generating electrical power is an externally bladed RAT located on the forward end of the pod. The Program Executive Officer for Tactical Aircraft Programs (PEO-T) has a specific interest in using the forward end of an advanced technology tactical jamming pod on the EA-18G advanced airborne electronic attack (AEA) aircraft as a preferred location for jamming transmit equipment. If the forward end of the pod can be populated with transmit equipment, the AEA aircraft will have better field of view for forward transmitting than for a pod with the RAT on the forward end. To accomplish this, an innovative approach is required to locate an internally bladed RAT inside the pod between the forward and aft ends.

Equipment cooling is traditionally provided by heat exchange between ram air and relatively large and heavy finned heat sinks. For the new technology pod, the U.S. Navy seeks weight savings and better antenna field of view through the minimization of heat sinks. Therefore, the power and cooling unit must chill a liquid coolant that will be pumped throughout the pod to provide cooling to all electrical equipment.

The Navy is seeking ram air driven power and cooling unit technology for the new AEA jamming pod (previously called the next generation jammer pod). The unit must have the potential to generate 60 kilovolt amperes (KVA) of either DC or continuous 115 VAC, 3-Phase, 400-Hz power while operating within both the current and potential future performance envelopes for the AEA jamming pod. Mechanisms for providing a constant electrical power frequency and for minimizing air drag when electrical power and cooling is not required must be demonstrated.

PHASE I: Determine the feasibility and technical merit of using an internal pod ram air turbine to provide both cooling and electrical power for an aircraft pod. Develop a conceptual design with limited design of critical components and a recommended design approach for the complete system. Show the cooling capacity of the system using thermal analysis of the conceptual design. Show the electrical production capability of the system using airflow analysis of the conceptual design.

PHASE II: Continue development of the advanced ram air driven power and cooling unit by performing detailed design of all system components. In order to optimize the design, perform computational fluid dynamic analysis of the system. Perform structural analysis with respect to the EA-18G environment. Perform a complete thermal analysis for cooling capability. Fabricate a prototype operational ram air driven power and cooling unit that can supply the required electrical power and provide adequate cooling for simulated equipment using up to 60 KVA. Demonstrate the capability of the system by airflow testing of the power and cooling unit.

PHASE III: Continue the design of the ram air driven power and cooling unit by incorporating design improvements obtained through Phase II testing. Integrate the design into the AEA jamming pod, and design the system for operation in the aircraft environment. Begin limited production of the ram air driven power and cooling unit for flight and environmental testing. Develop reliability and maintainability predictions and total ownership cost analysis.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Applications for a ram air driven power and cooling unit exist for civilian aircraft, tactical and nontactical military aircraft, and both manned and unmanned aircraft. Commercial uses of the power and cooling unit include civilian and unmanned aircraft, in which a pod application such as communication equipment would be improved by having the advantages of a ram air driven power and cooling unit.

REFERENCES:
1. AV-128jcs-5D; Design Control Specification for Ram Air Turbo-Generator. http://www.crane.navy.mil/tdc

2. AV-128jcs-19A; Design Control Specification for Case Assembly CY-(*)/ALQ-(*)

http://www.crane.navy.mil/tdc

KEYWORDS: Ram Air Turbine; Military Airborne Stores; Cooling, Power Generation; Liquid Heat Exchange; Electronic Warfare

N04-240 TITLE: Advanced Nonskid Coating System for Mobile Airfield Landing Mats

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a durable, heat-resistant, long lasting nonskid coating system for Marine Corps AM2 mat for V-22 and JSF landing and takeoff.

DESCRIPTION: The Marine Corps AM2 mat is a key component to the Marine Corps Expeditionary Airfield concept. The mat is used to construct airfields in forward operating areas, and can support virtually any fixed- or rotary-wing aircraft in the DoD inventory. These mats are robust and able to withstand tailhook impact and the landing loads imposed by the aircraft even when installed over marginal soil conditions. The mats are formed from aluminum alloy 6061-T6, and are 12 feet (or 6 feet) long by 2 feet wide, by 1-1/2 inches thick. The mats have interlocking edges that allow them to be connected to form airfields of any configuration. The top surface of the mat is currently coated with an epoxy-based nonskid coating. This coating requires frequent replacement due to wear or breakdown from the environment. All coating work is accomplished on the individual mats in a factory environment. A more durable, long lasting nonskid coating is sought. The coating should last the 20-plus-year lifetime of the mat

The technical challenges to this project are:

- Slip resistance (nonskid performance)
- Heat resistance (thermal protection)
- Insulation of the mat surface
- Light weight (no impact in overall weight and dimension of the mat)
- Adhesion to aluminum substrate subject to slight flexing
- Prevention of or resistance to undue abrasive damage to arresting gear cables or woven nylon arresting tapes
- Corrosion protection of aluminum

Additionally, an application process is sought that can achieve economical production in a manufacturing facility. The proposed coating system should not present any environmental (toxicity) hazards from its application, use, or eventual removal or disposal.

PHASE I: Propose materials, testing requirements, application methods, and projected costs for materials and application processes. Provide a technical and economic analysis of the application process projecting production rates and efficiency. Provide an analysis of health, safety and toxicity concerns of the coating and all aspects of the coating process. Provide supporting analysis to prove the feasibility of the material(s) to achieve the performance and life goals. The cost goal is $8 per square foot of applied coating.

PHASE II: Perform bench scale coating tests as required to develop and prove coating system properties. Develop, demonstrate and validate a prototype coating systems. Demonstrate application process by coating to full scale mats that will be provided as government furnished equipment.

PHASE III: The coating system, upon meeting the Marine Corps requirements, will be transitioned into the AM2 Mat refurbishment program for application to mats during their rework cycle.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are two commercial outcomes from this project: the materials and application process. The materials have application in areas that require temperature resistance and provide corrosion/nonskid properties to aluminum substrates. (metal processing industry, ship decks, missile launch pads). The basis for the application process will be fostering high production rates that render the process more cost effective. This technology could be transferred to any industry that applies similar type coatings in a factory environment.

REFERENCES:
1. MIL-C-81346B, Compound, Deck Covering, Nonslip, Lightweight for Aluminum Alloy Landing Mats.

KEYWORDS: AM2 Mat; Airfield; Nonskid; Heat Resistant; Corrosion Protection; Lightweight

N04-241 TITLE: Detecting Target Maneuvers with the Radar Range Rate Measurement

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-234, A-6/EA-6

OBJECTIVE: Develop an advanced capability to detect target maneuvers using the Doppler velocity range rate measurement from a surveillance radar to improve its ability to track radar targets.

DESCRIPTION: The goal for any target tracking system is to give the most accurate representation of where a target is at any given point in time. There are two classes of motion models used in target tracking, one for maneuvering targets and one for non-maneuvering (constant velocity and acceleration) targets. Under these two classes, numerous motion models exist that can be applied to predict and propagate tracks for a particular target. The area that is still lacking in target tracking is the ability to detect reliably when a target is beginning a maneuver. The tracking system can then switch the algorithms applied to the problem from a non-maneuvering set to the maneuvering set. The errors in distance from where the tracker estimates the position of a target and the actual position can be very large when the incorrect motion models are applied to the problem. Additionally, when the tracker does finally catch up to the target after the maneuver, the track will "jump" across the operator's scope giving a very unrealistic and unreliable picture of what that target is actually doing.

Emerging technology is sought for detecting radar target maneuvers with the Doppler velocity, or range rate, measurement. Recent results show that proper exploitation of surveillance radar's range rate measurement has the potential to reliably indicate the presence and magnitude of a target maneuver. Investigate the applicability of this new technology for the E-2C's radar operating environment and mission, and the best way to integrate it into the E-2C's radar tracker. Simulated and recorded data will be used.

PHASE I: Develop a simulation of the E-2C's operational profile, radar, and tracking algorithms to demonstrate the feasibility and potential benefits of using the range rate measurement to detect maneuvers.

PHASE II: Develop, demonstrate and validate prototype algorithms and software for the range rate based maneuver detection and estimation technology.

PHASE III: Fully develop algorithms and software and demonstrate their performance benefits over the existing system using validated E-2C data sets. Integrate the advanced range rate based maneuver detection and estimation technology into an E-2C hardware-in-the-loop simulator and demonstrate the capabilities in a real-time mode.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Maneuver detection technologies can be applied to a wide range of commercial applications including emergency control centers, law enforcement, and traffic control.

REFERENCES:
1. Y. Bar-Shaolom, W.D. Blair (eds), Multitarget-Multisensor Tracking: Applications and Advances, Volume III, Artech House, 2000

2. Y. Bar-Shalom, X. R. Li, Multitarget Multisensor Tracking: Principles and Techniques, YBS Publishing: Storrs, CT, 1995.

3. D.F Bizup, D.B. Brown, Maneuver Detection Using the Range Rate Measurement, IEEE Transactions on Aerospace and Electronic Systems, Vol. 40, No. 1, 2004

4. D. F. Bizup, Detecting Manuevers with the Range Rate Measurement, Proceedings of the 7th International Command and Control Research and Technology Symposium, 2001

5. D.F. Bizup, Improving Target Tracking with the Range Rate Measurement, Ph.D. Disseration, University of Virginia, 2003

6. S. S. Blackman, R. Popoli, Design and Analysis of Modern Tracking Systems, Artech House: Norwood, MA, 1999.

7. C. Y. Chong, S. Mori, W. H. Barker, K. C. Chang, “Architectures and algorithms for track association and fusion,” IEEE Aerospace and Electronic Systems Magazine, vol. 15, pp. 5-13, 2002.

8. T. Kirubarajan, etal., Multitarget Tracking Using an IMM Estimator with Debiased Measurements for AEW Systems, Proceedings of the Second International Conference on Information Fusion, Vol 1, pp262-269

9. R. Schutz, etal., Maneuver Tracking Algorithms For AEW Target Tracking Applications, Proceedings of the SPIE Conference on Signal and Data Processing of Small Targets, Vol 3809, pp308-319

KEYWORDS: Multi Sensor; Information Fusion; Target Tracking; Range Rate; Maneuver Detection; Motion Models

N04-242 TITLE: Rugged, Low-Cost, Nondielectric Missile Radome

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA-242, Defense Suppression Systems

OBJECTIVE: Develop a radome that can be manufactured using simple material and process techniques.

DESCRIPTION: The U.S. Navy is continually improving the capability of radio frequency (RF) systems used in a wide range of frequencies and operational and environmental conditions. Applications range from communication systems to high-speed missile seekers. Common to all these systems is the need for a producible radome that can handle a wide range of environmental requirements. Current radome designs include solid laminates and sandwiched configurations. Solid radomes require the use of materials with unique thermal, RF, and structural properties. For many applications such as high-speed missiles, the supplier base is limited due to the complexities of manufacturing. Sandwiched radomes, on the other hand, require costly processes involving complex lay-up and bonding of multiple layers of materials in a three-dimensional configuration. High-speed missiles have one of the most demanding radome requirements and are the primary objective of this SBIR topic. Such radomes have to be able to operate over a wide range of structural and thermal loads while operating with minimal loss at short wavelengths. In addition the radomes have to possess well-characterized and repeatable boresight error and error slope (Reference 1).

Alternative radome designs are desired that can be manufactured and characterized using simple materials and processes. As an example, radomes that can be manufactured from blocks of common insulators and/or common conductors have the potential to reduce cost. Metal radomes with slots or holes are particularly of interest. A practical example is given in Reference 2 using a thick-wall frequency selective surface. Manufacturing techniques such as machining with inherently tight tolerances are of interest. The ability to model and simulate such radomes over wide scan angles and polarizations is critical. In general, it is critical to demonstrate the ability to correlate measured and analytical models in order to demonstrate that the proposed design can be characterized through potential follow-on phases of the program where a thorough performance model of the radome is required.

PHASE I: Analyze candidate metal or other nontraditional radome designs that will operate at X-band, Ka-band, and W-band wavelengths and in a high-speed environment. Predict and document performance parameters such as polarization, loss, bandwidth, beam transmission and distortion, and boresight error and error slope of the selected candidates. Fabricate 4x4-inch flat test samples of the selected radome material and test and measure the electrical, thermal, and mechanical characteristics of the test samples. Develop a plan for using the best material/method to fabricate full-size radomes.

PHASE II: Fabricate and test full- size radome prototypes using the technical approach developed in Phase I. Demonstrate the availability of materials and processes for development of a full-scale model capable of flight tests. Conduct electrical, mechanical, and thermal tests on the prototype radomes to verify their suitability for the high-speed missile radome application.

PHASE III: Fabricate and test a flight worthy radome.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Potential commercial applications include aviation and maritime broadband communications systems, and weather and collision avoidance radar systems where high-performance low-cost radomes are essential.

REFERENCES:
1. Walton, J. D. Radome Engineering Handbook Design and Principles. Georgia Institute of Technology, Marcell Dekker, Inc., 1970.

2. Wu, T. K. Frequency Selective Surface and Grid Array. John Wiley & Sons, Inc., 1995, pp. 164-179.

KEYWORDS: Radome; Missile Radome; Metal Radome; Nondielectric, RF Systems, High-Speed Missiles

N04-243 TITLE: Multi-Level Secure High-Speed Shared Memory Interconnect

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Using emerging technology, develop the hardware modifications and supporting software modifications to present commercial computer interconnects necessary for an advanced multi-leve secure, shared-memory (non-cached) avionics processing system using serial technology, and with the attributes of high speed, low latency, and low cost.

DESCRIPTION: Next-generation real-time avionic interconnects will be characterized by high speed (to support applications such as signal processing), support of many processors, and support of multi-million lines of software classified at multiple security levels (unclassified, secret, top secret, etc.). To avoid a "system high" environment where all multi-million lines of software must be treated as if they were classified at the highest level present (often top secret, thus dramatically increasing software costs), multi-level secure systems are desirable. In multi-level secure systems, only the small amount of software that is actually classified must be specially managed. Current multi-level secure interconnects are usually message passing systems, rather than the faster shared-memory systems, because today's shared-memory interconnects do not provide the features necessary for security. By adding additional hardware features, such as memory access registers and the software modifications to control them, to today's shared-memory interconnects, a multi-level secure, shared-memory (non-cached) interconnect can be achieved.

Current state-of-the-art, real-time avionic multiprocessor interconnects are of relatively high cost, weight, volume, and power. State-of-the-art technologies are needed to achieve the interconnect goals of high speed, low latency, and low cost, in a low-weight, volume, power envelope. This includes technologies such as low-voltage differential signals, serialization, high-speed integrated circuits, and perhaps fiber optics. Innovation is needed to allow real-time shared-memory systems to operate at multi-level security and to be combined with these new technologies.

Leveraging existing COTS technology is necessary to achieve low cost and accomplish this project within SBIR resources. Rather than inventing new protocols from scratch, it is anticipated that offerors will modify an existing protocol (for which firmware already exists) such as RapidIO, Scalable Coherent Interface, or other. Implementation in advanced field programmable gate arrays to save development costs are suitable, depending upon protocol efficiency, logic design and size, and speed requirements. Use of Linux or other existing software is acceptable to further hold down development costs.

(NOTE 1: As used here, latency refers to the time required for the target application software to receive the needed data over the interconnect system. Message passing systems, even those with very high bit-per-second measurements, often invoke large delays before and after passing the data. Shared-memory systems do not generally experience these delays.)

PHASE I: Develop and assess a preliminary design of the interconnect registers and other features that would need to be added to an existing interconnect system to support multi-level secure, shared-memory (non-cached) systems. Analyze the likelihood of security compromises with such a shared-memory interconnect system.

PHASE II: Develop the interconnect hardware, interconnect software modifications to existing systems as identified in Phase I. Fabricate a prototype and demonstrate a multi-level secure, shared-memory (non-cached) interconnect system. Finalize the system design. Attaining National Security Agency (or other) accreditation for the system developed is considered beyond the scope of this SBIR. It should be accomplished by the first fielded implementation.

PHASE III: Develop a COTS product. Conduct full-scale field demonstration. Finalize production processes and software.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High-performance secure computer technology that will be applicable to all forms of military computing will be applicable to other industries needing security such as the financial sector.

REFERENCES:

1. http://www.computer.org/cspress/CATALOG/ST01049.htm
2. http://www.scizzl.com/
3. http://www.rapidio.org/


KEYWORDS: Secure Computing; Shared Memory; Real-Time; Multi-Processors; Avionics; Military Computing

N04-244 TITLE: Field Programmable Gate Array (FPGA) Processor Firmware Development Modularization Methodology

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a methodology and products for FPGA applications to be hardware independent (allowing easy migration to new FPGAs), to be easily upgraded to add new firmware functionality, and to require less regression testing after upgrades.

DESCRIPTION: FPGAs provide an excellent way for systems to deal with high-speed signal processor functions such as image processing, which could not be as efficiently implemented in a conventional microprocessor. Most current FPGA applications are highly coupled with the hardware, are difficult to upgrade and modify, and require considerable regression testing. Currently, hardware upgrades to newer FPGAs usually require application changes that increase cost and schedule.

A methodology is needed to resolve these difficulties. Tools, guides, control processor middleware, and/or FPGA middleware could be used to implement the methodology. For example, a scheme might be developed to abstractly write applications in a more modular fashion. In such a scheme, new functionality to the application firmware should limit changes to existing applications. After these upgrades, the modularization scheme should provide a high level of confidence that limited regression testing is needed. To be useful this abstraction/ modularization scheme should look at the following areas of importance:

- The methodology (and implementation artifacts) should support a wide range of signal/image processing applications.
- Application writers should require minimal knowledge of the underlying hardware in order that the application can be mapped onto a variety of different architectures/FPGAs.

- The scheme should include a method for debugging. For example, configurable test points should be provided that provide all necessary system visibility.
- The scheme yields FPGA logic that makes efficient use of FPGA resources. It should be possible to utilize a large percentage of the FPGA resources available; i.e., 80 percent or better of the FPGA should be usable.
- The scheme allows adding functionality and modifications without large rewrite/rework.
- Any upgrades or modifications to the application firmware have a limited and traceable impact on existing functionality.

PHASE I: Develop a concept and basic methodology for implementing easily upgradeable, hardware independent FPGA applications keeping regression testing to a minimum.

PHASE II: Implement the tools, guides, control processor middleware, and/or FPGA middleware for the methodology developed in Phase I. Show an example application based on this scheme on multiple hardware configurations to demonstrate its isolation from the different hardware. Establish a level of confidence metric to guide the amount of expected regression testing needed to show that existing application functions the same on the new hardware and that any added functionality does not adversely affect the existing applications.

PHASE III: Insert the product into the Joint Strike Fighter or other program, as systems are upgraded.

PRIVATE SECTOR COMMERCIAL POTENTIAL: FPGAs are being used more and more frequently commercially. The tradeoff between open design and performance is not a new one, and a scheme and tools such as has been described would be useful in many areas such as security recognition hardware and medical imaging.

KEYWORDS: FPGA; Signal Processing; Middleware; Firmware; Open Architecture; Image Processor Element (IPE)

N04-245 TITLE: <u>Light Detection and Ranging (LIDAR) Surface Feature Extraction Tool</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMA-205 (Aviation Training Systems); Joint Strike Fighter (JSF)

OBJECTIVE: Develop innovative technology to use LIDAR source data in creating visual/sensor databases used for mission rehearsal and other real-time training.

DESCRIPTION: LIDAR data provide great potential for extracting the location, orientation, and identification of terrain surface features. These three-dimensional surface features need to be identified and inserted into the visual database, which defines the virtual environment used in real-time immersive training. LIDAR data can provide very high spatial resolution as well as distinct returns on vegetation versus other surface features. A prototype software tool to extract buildings and vegetation from LIDAR exists; the toolkit is an ArcView extension, but it is not a production grade tool. A new effort to build a production grade LIDAR extraction tool that works on large files, pulls out more features, and is easier to use would benefit the Navy's mission rehearsal community by dramatically increasing our cultural feature production efforts. The payoff to the warfighter's situational awareness in the urban area would be invaluable. There is no current auto-extraction tool available that is a viable candidate for this role. If this technology is successful, it will fulfill a significant requirement for mission rehearsal, large urban cultural feature availability. Savings in manpower in manually building an urban area would be the direct return on investment. Proposed technologies should work toward a solution that fits with the Navy Aviation Simulation Master Plan (NASMP) Refined Source Data (RSD) initiative. Specifically, the software tool output should be in a format that will be available to all other Navy programs. It should be set up such that programs not committed to Topscene will also benefit.

PHASE I: Provide a proof-of-concept demonstration that includes effectiveness of at least one important interpretive algorithm using actual satellite/aerial imagery. Demonstrate incorporation of the solution into a visual database, which is run in real time. Determine the feasibility of how the proposed solution will work around graphic board/computer hardware limits and how it will effectively work with run-time software.

PHASE II: Add additional interpretive algorithms, which improve the quality. For example, match the feature location, orientation, and appearance to the ortho-rectified terrain surface image for many feature types under difficult lighting and obscuration conditions. This may include creating a reference library of surface models and a library of model types, which are adjustable to provide a better match of individual features. Develop a prototype to demonstrate the automated tool's ability to create or improve a visual database to meet a training need.

PHASE III: Refine the software used in Phase II to be an industry useful software tool. This may include improving robust functionality, make it easier to learn, and use documentation.

PRIVATE-SECTOR COMMERCIAL POTENTIAL: Real-time, high-performance simulation, such as flight trainers for commercial aviation. All users of aerial photography for land management and city planning would benefit. (i.e., forestry, road planning, tax assessment, etc.).

REFERENCES:
1. "Processing LIDAR for 3D Urban Visualization." Presented by Stelle of BAE Systems at the Image Society Conference July 2003.

KEYWORDS: Simulation; Imaging; Visual; Reconnaissance; Data Base; Training

N04-246 TITLE: Management of Imagery Data in Simulation Training Systems Via Content Based Retrieval and Indexing

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMA-205 (Aviation Training Systems); Joint Strike Fighter (JSF)

OBJECTIVE: Develop innovative content addressable techniques for the retrieval and indexing of imagery databases in training systems.

DESCRIPTION: Imagery-based content is an important component of modern simulation training systems. Efficient utilization of this content requires the management of large volumes of non-alphanumeric information, computations and communications, and the visualization of results. As images are being generated at an ever-increasing rate, content-based information retrieval (CBIR) systems can effectively and efficiently organize (index) and retrieve visual information from large simulation training databases consisting of both textual and graphical (video) imagery. Because information contents may include pictorial information to allow for multimedia applications and visualization, there is a need to query large on-line image databases using the image's content. Various technological challenges should be investigated. The derivation and computation of attributes (features) of images and visual objects are key issues that can provide useful query functionality for search and retrieval. Adapting (learning) student/exercise profiles for better training performance can lead to automatic query attribute generation. Other important issues include developing retrieval methods based on similarities as opposed to exact matches, querying by image examples or user drawn images, developing the pictorial querying language, and designing the user interfaces, and query refinement and navigation.

PHASE I: Explore innovative concepts for content-based image retrieval for simulation training systems and provide proof of the feasibility of the initial experiment.

PHASE II: Provide a scaleable software demonstration and validation of the most promising technique of content-based image retrieval on selected simulation training platforms.

PHASE III: Develop a plug-in module for commercial graphic rendering software that both archives and serves as an "accelerator" for graphic display list processing of computationally intensive mission databases.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial range of applications can be applied to the pictorial information archiving and processing needs of various media and commercial entities. Both military and nonmilitary applications benefit. Both sectors require new processes for generating, correlating, indexing, and rendering far greater levels of imagery and related data.

KEYWORDS: Imagery Management; Training Systems; CBIR; Simulation Training; Feature Recognition; Information Archival

N04-247 TITLE: Littoral Environment Parameter Estimation from Bistatic and Multistatic Fleet Air Antisubmarine Warfare (ASW) Acoustic Reverberation Data

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290, Maritime Surveillance Aircraft; PMA-299, H-60 Multi-Mission Helic

OBJECTIVE: Develop a technique for estimating the littoral acoustic environment from bistatic and/or multistatic acoustic reverberation data collected by current and emerging Fleet air ASW platforms.

DESCRIPTION: Active air ASW platforms currently collect a significant amount of bistatic and multistatic acoustic reverberation data. Current acoustic data inversion tools have matured to the point where they can invert measured monostatic reverberation data to produce an estimate of some elements of the acoustic environment. The progression toward the use of bistatic and multistatic reverberation data will need to mitigate the increased complexity of modeling the environment at a sufficient level of accuracy to capture the characteristics of the observed reverberation data. In addition, this increase in modeling complexity can result in a significant increase in computational requirements that must be balanced against the operational requirements from the Fleet. The abundance of bistatic and multistatic reverberation data, when compared with monostatic reverberation data, presents a great opportunity if these challenges can be overcome with an innovative approach.

PHASE I: Develop the proposed environmental parameter estimation technique in sufficient detail to allow the evaluation of both the modeling approach and the computational requirements. Approaches should use Navy standard models and databases when possible. Approaches must provide a framework concept of operations for their technique to allow its impact on the Fleet air ASW platform mission to be understood.

PHASE II: Complete the Phase I environmental parameter estimation technique and develop a prototype processing system using the new environmental estimation algorithm. Demonstrate and evaluate the environmental estimation prototype system using both monostatic and bistatic/multistatic reverberation data provided by NAVAIR (collected from various Fleet air ASW platforms).

PHASE III: Transition prototype to operational Fleet air ASW platform(s) or to commercial/marine applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are a variety of commercial areas in which an accurate knowledge of littoral environment is desired. These include underwater communications, the tracking of marine mammals, marine construction, and global warming.

REFERENCES:

1. Miyamoto, Robert T. "A Brief Description of Bottom Properties, Measurement Techniques, and Assimilation Needs to Support the Tactical Acoustic Measurement (TAM) System." Applied Physics Laboratory, University of Washington, 4 May 1999.

2. Defense Technology Area Plan, Chapter VII-Sensor Electronics, and Battlespace Environment. http://www.fas.org/spp/military/docops/defense/97_dtap/sensors/ch070303.htm

KEYWORDS: Reverberation; Bistatic; Multistatic; ASW, Inversion; Environmental Parameters

N04-248 TITLE: Low Cost Three-Dimensional Reinforced Ceramic Matrix Composites (CMCs)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Define and demonstrate low-cost three-dimensional CMC architectures and associated manufacturing processes needed for application to advanced military aircraft gas turbine engine components.

DESCRIPTION: The JSF and other advanced military aircraft platforms are targeting CMCs for use in the propulsion system to reduce weight. However, there are risks associated with service life durability and production cost.

Two-dimensional CMC components have been found to be life-limited in high thermal gradient environments due to inherently low matrix dominated interlaminar shear strengths. Three-dimensional architectures offer the potential for increased durability by enhancing the interlaminer and through-thickness mechanical properties. However, ineffective and inefficient processing issues need to be resolved.

The application of three-dimensional architectures is problematic relative to implementing low-cost manufacturing processes. Efficient methods for ensuring fiber integrity and achieving adequate densification are especially important.

Overall the effort needs to properly consider and balance the effects of the three-dimensional architecture and its associated manufacturing processes to achieve affordability and durability benefits. Input from the JSF propulsion system contractors, existing CMC manufacturing sources and/or common practices should be implemented in order to further the state-of-the-art technology.

PHASE I: Define a low-cost three-dimensional CMC architecture and its associated manufacturing processes for application to the JSF propulsion systems. Demonstrate the feasibility of the low cost three-dimensional architecture and manufacturing processes through fabrication and testing of coupon specimens.

PHASE II: Apply the three-dimensional architecture on a JSF propulsion system part and fabricate the part using the associated manufacturing processes. Demonstrate the production-scalability of the manufacturing processes. Define the required test plan for validating the affordability and durability of the three-dimensional architecture and its associated manufacturing processes. Evaluate affordability and durability through the fabrication and testing of a sufficient quantity of test specimens and/or parts.

PHASE III: Transition the CMC system to the JSF or another military aircraft propulsion system. Future use may involve hypersonic aircraft propulsion systems, the J-UCAS propulsion systems and new commercial engines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced CMC propulsion components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy. The resulting processing approaches can transition to the energy and chemical industries for such applications as hot gas filters, radiant burners, corrosive handling equipment, waste incinerators, and power turbines.

REFERENCES:
1. MIL-HDBK-17-5, Volume 5, Ceramic Matrix Composites.

2. Kedward, K. T., and Ward, D. D. “The Development and Application of Composites for Large Aeroengine Fan Blades.” Comprehensive Composite Materials, Vol. 6, Chapter 11, Editors: Kelly, A. and Zweben, Carl. Oxford, UK: Elsevier Science Ltd., 2000.

3. Lu, T. J.,. and Hutchinson, J. W. “Role of Fiber Stitching in Eliminating Transverse Fracture in Cross-Ply Ceramic Composites.” J. Am. Ceram. Soc., 78[1], 1995, pp. 251-53.

4. Langlais, F. “Chemical Vapor Infiltration Processing of Ceramic Matrix Composites.” Comprehensive Composite Materials, Vol. 4, Chapter 20, Eds: Kelly, A., and Zweben, Carl. Oxford, UK: Elsevier Science Ltd., 2000.

KEYWORDS: Propulsion Systems; Ceramic Matrix Composites; Interlaminar; Thermal Conductivity; Fiber Architectures; Manufacturing

N04-249 TITLE: Innovative Quality Control Assessment Methods for Ceramic Matrix Composite (CMC) Components

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop innovative technologies to integrate nondestructive evaluation (NDE) techniques and associated analytical models into the CMC manufacturing process for cost reduction, quality improvement, and improved process understanding.

DESCRIPTION: Various NDE approaches, including thermography, ultrasound, and x-ray, have been utilized for assessment of the presence of manufacturing flaws within prototype CMC components. Correlation of the NDE results with actual flaws, and ultimately with the influence of a given defect on the performance of a manufactured component, is lacking. Innovative approaches are required both in correlating flaws with their NDE “signature” and in efficiently coupling the NDE results with structural models for the determination of the influence of a given flaw on thermo-structural performance. Integration of such an approach early in the CMC manufacturing process would provide for identification of incipient flaws, such as delaminations and incomplete infiltration, and assessment of the ability of the component to meet performance requirements. This will provide for a more efficient manufacturing process by providing acceptance/rejection criteria for CMC components with fabrication induced flaws. Integration of these innovations into the normal manufacturing process will pay a large dividend in cost reduction, result in more consistent component performance (improved quality), and lead to improved process and product understanding. The JSF and other military platforms are considering CMCs for engine applications. Cost and quality are key issues that must be addressed, and utilization of innovative quality control methods will help address those needs.

PHASE I: Evaluate the use of NDE techniques on CMCs as early in their fabrication process as is feasible (possibly with intentionally introduced flaws) to demonstrate the ability to identify flaws. Correlate the NDE indication with the actual flaw and its effect on the material performance via destructive evaluation and characterization of CMC coupons. Consider the material process flow and identify the optimum time(s) in the process cycle for NDE. Identify analytical tools that could account for and predict the impact of known flaws in the material.

PHASE II: Develop, demonstrate, and validate prototype NDE technology and associated analytical tools. Develop accept/reject criteria based on mechanical properties testing, destructive flaw evaluation, and analytical modeling.

PHASE III: Optimize the NDE system and methodology for the chosen component(s). Extend the analytical model to account for flaw orientation and position within a component. Undertake the demonstration necessary to qualify the NDE process. Modify the existing material process specifications to include the NDE process.

PRIVATE SECTOR COMMERCIAL POTENTIAL: NDE CMC technologies have the potential to transition to the energy and chemical industries by providing a quality control criteria applicable to CMC’s for such applications as hot gas filters, radiant burners, corrosive handling equipment, waste incinerators and power turbines.

REFERENCES:
1. Stainbrook, Ellingson, Koehl, and Deemer. "Development of Volumetric Computed Tomography Using Flat-Panel X-Ray Detector for Large Ceramic Components." Ceramic Engineering and Science Proceedings, 23, 3, 2002, pp. 541-548.

2. Sun, Erdman, Russel, Deemer, Ellingson, Miriyala, Kimmel, and Price. "Nondestructive Evaluation of Defects and Operating Damage in CFCC Combustor Liners." Ceramic Engineering and Science Proceedings, 23, 3, 2002, pp. 563-569.

3. Ikeda, Nagano, and Kawamoto. "3D Image Construction of Porous Ceramics by X-Ray CT and Stress Distribution Analysis Using Voxel Mesh Method." Ceramic Engineering and Science Proceedings, 24, 3, 2003, pp. 177-182.

4. Ikeda, Yasutoshi, Mizuno, Mukaida, Neo, and Nakamura. "3 Dimensional CT Analysis of Bone Formation in Porous Ceramics Biomaterials." Ceramic Engineering and Science Proceedings, 24, 3, 2003, pp. 185-190.

5. Eldridge, Spuckler, Nesbitt, and Street. "Health Monitoring of Thermal Barrier Coatings by Mid-Infrared Reflectance." Ceramic Engineering and Science Proceedings, 24, 3, 2003, pp. 511-516.

6. Sun, Erdman, and Connolly. "Measurement of Delamination Size and Depth in Ceramic Matrix Composites Using Pulsed Thermal Imaging." Ceramic Engineering and Science Proceedings, 24, 4, 2003, pp. 201-206.

KEYWORDS: CMC; NDE; Manufacturing; Modeling; Cost Reduction; JSF

N04-250 TITLE: Environmental Resistance for Ceramic Matrix Composites (CMCs)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a coating or additive to current CMCs to enhance their resistance to the salt environment.

DESCRIPTION: The JSF and other military platforms are using CMCs for engine applications. The combination of high temperature and salt degrades the mechanical properties of these materials by a process known as "hot corrosion." The salt is derived from the fuels, moisture in the air, and salt mist that may be ingested in the engine while the platform is on the carrier deck. There is a need to understand the mechanisms involved in this degradation process as well as an approach to hinder the corrosion of these materials.

PHASE I: Demonstrate an understanding of the hot corrosion processes on existing CMC systems. Determine the mechanisms of degradation on a CMC system such as that proposed for the JSF. Analysis may include use of a scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and X-ray diffraction of the material. Perform mechanical testing on the material system to determine the effects of the salt environment. Develop and evaluate an innovative approach to protect the CMC. Compare the testing results with the baseline information from the nonprotected CMC.

PHASE II: Continue optimization of the protection scheme for the CMC. Characterize and validate the performance of the new system by testing specimen composition, uniformity, and microstructure and physical characteristics like wear, adhesion (if a coating), moisture resistance, hot corrosion resistance, thermal stability (oxidation/creep), and fatigue effects.

Specific aircraft parts will be selected to apply the new CMC system. These parts should be chosen with the aid of an engine manufacturer to enhance the probability of transition. After selected parts are manufactured, they should be tested for hot corrosion resistance, oxidation, mechanical properties, and quality (this may include nondestructive testing). Develop a plan for engine demonstration.

PHASE III: Transition the CMC system to military aircraft. Future use may involve hypersonic platforms, the joint unmanned combat air systems (J-UCAS), and new commercial engines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The ability of a CMC to withstand the harsh marine environment could be transitioned to sea based turbines and heat exchangers.

REFERENCES:
1. Richardson , G. Y., Lei, C. S., and Singh, R. N. "Influence of Burner-Rig Exposures on the Mechanical Properties of Ceramic Matrix Composites." Proceedings of the 24th Annual International SAMPE Conference, Baltimore, MD, 2002.

2. Richardson, G. Y. "Environmental Effects on SiC/C CMC's for Turbine Engine Applications." American Ceramic Society, Cocoa Beach, January 1999.

3. Richardson, G. Y., and Kowalik, R. W. "F414 Exhaust Nozzle Flaps & Seals." Presented and Published at the 22nd Annual Cocoa Beach Conference and Exposition, January 1998.

4. "Testing and Evaluation of Ceramic Matrix Composites for Navy Air Vehicle Applications." 27th Annual CMC Conference, Cocoa Beach, Florida, January 27-30, 2003.

5. "Influence of Turbine Engine Environment on the Mechanical Properties of Ceramic Matrix Composites. 34th International SAMPE Technical Conference Proceedings, Baltimore, Maryland, November 4-7, 2003.

6. Haque, Anwarul; Rahman, Md. M., Mohamed, Hisham, T., Mahfuz, Hassan; Vaidya, Uday, K., Jeelani, Shaik. Durability and Damage Development in Woven Ceramic Matrix Composites Under Tensile and Fatigue Loading at Room and Elevated Temperatures. Alabama, Tuskegee: Tuskegee University, Center for Advanced Materials, American Society of Mechanical Engineers), 1999.

KEYWORDS: Hot Corrosion; CMCs; Oxidation; Propulsion; Engine; Aircraft

N04-251 TITLE: High-Temperature Sizing Development

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop an improved sizing system for carbon fiber that allows better handling during the manufacturing process. New sizing concepts must exhibit thermal stabilities during the full processing cycle for phenyl ethynyl end-capped polymer matrix composites. In addition to the thermal requirement, the developed sizing must be chemically compatible with fluorinated addition polyimide systems.

DESCRIPTION: High-temperature polymer matrix composites offer significant advantages for military engine and airframe applications through reduced weight and improved stiffness over comparable metal components and structures. However, to manufacture aerospace quality components, fiber sizing concepts need to be developed that improve handling of tow for woven prepregs as well as dry fiber preforms.

PHASE I: Demonstrate new sizing concepts that are compatible with phenyl ethynyl end-capped fluorinated addition polyimides for applications involving use temperatures of 550°F or higher. Perform a cost analysis to estimate cost savings when compared to unsized carbon fiber prepreg and dry preforms.

PHASE II: Develop and demonstrate the necessary capabilities and process controls to produce high-temperature sizings with the required quality control, thermal stability, and chemical compatibility with current addition polyimide systems. Identify technology transition targets with the primary focus on engine requirements.

PHASE III: Demonstrate the transition of the developed sizing concepts to military weapon systems through component fabrication and testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High-temperature sizing development would have broad application to commercial aviation if low-cost processing techniques could be used for manufacturing high-temperature polymer matrix composites (HTPMCs) utilizing techniques such as resin transfer molding (RTM), resin film infusion (RFI), and vacuum assisted RTM (VARTM).

REFERENCES:
1. Gray, R. "Increasing the Thermo-Mechanical Performance of High-Temperature Composites by Improving the Fiber Matrix Interface." Proc. High Temperature Workshop XVIII, 1998.

2. Eby, R. "Studies of PAN Based Carbon Fiber Surfaces/Bonding PMR15/Thermal Oxidative Stability." Proc. High Temple Workshop XVII, 1997.

KEYWORDS: High-Temperature Polymer Matrix Composites (HTPMCs); Fiber Sizing; Resin Transfer Molding (RTM); Resin Film Infusion (RFI); Vacuum Assisted Resin Transfer Molding (VARTM); Manufacturing

N04-252 TITLE: High-Temperature Adhesive Development

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a high-temperature film adhesive based on addition polyimide chemistry. New adhesive formulations must provide a continuous service temperature in excess of 600°F for up to 1,000 hours retaining 1000-psi lap shear strength.

DESCRIPTION: The need to increase performance of aerospace structures and jet engines is driving the requirement for higher temperature capable polymer matrix composites and adhesives to bond these components to other structures. Current high-temperature adhesives are generally restricted to temperatures below 600°F and cannot withstand higher temperature spikes typical of engine applications. This technology will provide new material systems for adhesive applications that can be incorporated into high-temperature propulsion applications.

PHASE I: Demonstrate adhesive formulation(s) and/or formulation process(es) for processing high-temperature adhesive films. New formulations must be compatible with addition polyamide composites as well as titanium substructure.

PHASE II: Develop the necessary capabilities and process controls to produce production-scale high-temperature adhesives with baseline properties equal to or exceeding FM680-1 with reduced volatile contents.

PHASE III: Demonstrate the transition of the developed adhesives to military weapon systems through component demonstration and testing. Compatibility with the F135 and F136 engine systems must be addressed.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High-temperature adhesives would have broad application to commercial aviation if performance requirements can be met with improved processing resulting in lower volatile management.

REFERENCES:
1. Ronk, W., Han, D., Boyd, J., and Pederson, C. "CYCOM AFRPE Prepregs: A New Class of High Temperature Materials." SAMPE Technical Proceedings, Dayton, Ohio, September 29, 2003.

KEYWORDS: High-Temperature Polymer Matrix Composites (HTPMCs); High-Temperature Adhesives; Propulsion; Structures; Materials; Addition Polyimide Composites

N04-253 TITLE: Threat Spectrum Direction Finding Unit

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290, Maritime Surveillance Aircraft; PMA-299, H-60 Multi-Mission Helico

OBJECTIVE: Develop a self-deploying covert sensor matrix package with the capability of crossing multiple operational environments.

DESCRIPTION:  The Services lack a covert/low-observable adaptive small package that will give them short- or long-term surveillance with the ability to direction find (DF) troop and material movement, and stationary and moving emitters/weapons fire in an elevated security and/or contested environment.  Having this capability may save lives by providing early warning, battlespace description, and quick response targeting solutions in dangerous, urban, and difficult terrain environments.

Innovative sensor technologies are sought that are capable of collecting, processing, transmitting, and displaying surveillance information.  These will include the development and integration of low-power, miniature electronics coupled with innovative sensor, transceiver, and battery technology in a multi-packaged A-size or smaller air-deployed package.  The technical challenges to consider include:
- Sensor spectrum (detect and classify potential targets)
- Radio frequency (RF), electro-optic (EO), infrared (IR), magnetic signals
- Muzzle flash spectrum (ultra-violet)
- Acoustic signals (airborne and ground)
- Sensor package (basic capability)
- Package location determination (GPS or equivalent accuracy)
- Provide bearing, velocity, and range estimate to emitter based on sensor input
- Transmit/receive instruction and data (real-time) with low probability of intercept (LPI) characteristics
- Sealed maintenance free and environmentally friendly battery; long life, rechargeable high power
- A government-developed air deployed GPS guided glider platform (approximately A-size (4.75-inch diameter x 36-inch length)) is volume constrained to roughly 4-inch x 24-inch length.  Multi-unit dispersion from a single platform is preferred.

Multi-consortium teaming is acceptable and may be preferred given this multi-discipline concept.  This may be done at the sensor, software, or integration levels.

PHASE I:  Develop a concept design of an air-dispensed/deployed covert/low-observable sensor package.  Identify the advantages, disadvantages, and risks of the proposed sensor matrix.  Establish feasibility through a limited laboratory concept demonstration verifying subcomponents and design.  Multi-point dispersion from a single "mother" unit is desired.

PHASE II:  Develop, demonstrate, and validate the prototype sensor package.  Incorporate the experimentation results into final and other concept designs.  Demonstrate the technology in a realistic tactical environment.

PHASE III:  This system will have immediate use in surveillance and monitoring operations with Homeland Security, Global War on Terrorism, Joint Forces Operations, and future combat systems under development.  Commercially this product could be spun off to enable remote monitoring of facilities and vital infrastructure assets.

PRIVATE SECTOR COMMERCIAL POTENTIAL:  Police enforcement during surveillance, drug, and hostage situations; industrial park remote security, school ground surveillance.

REFERENCES:
1. Joint Publication 3-06, Doctrine for Urban Operations, 16 September 2002.

KEYWORDS: Acoustic Sensors; Micro Electro-Mechanical Systems; Digital Compass; Signal Processing; Rechargeable Battery; Counter-Sniper

N04-254 TITLE: <u>Low-Cost Fiber-Optic Connector Cleaner</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-265, F-18

OBJECTIVE:  Develop innovative low-cost processes and materials for cleaning fiber-optic connectors, which do not require the disassembly of the connectors.

DESCRIPTION: In order for optical fibers to be effectively used for communications, rematable connections are required. The most common design for fiber-optic connectors uses precision ferrules to hold the fiber. The ferrule (sometimes called a terminus) on one side of a connection is held in a bushing/adapter (female side), which is secured inside an assembly (e.g., weapon replaceable assembly (WRA) or line replaceable unit (LRU)) or on a bulkhead. The other side (male) is pushed into the bushing/adapter to make the optical connection. In order for the connector to have low loss (i.e., good performance), the surfaces must be perfectly clean and free of obstructions that might otherwise block the light transmission. MIL-DTL-38999 and MIL-C-28876 are examples of typical connector housings for fiber-optic termini.

Commercially available cleaning tools (e.g., alcohol wipes) are relatively inexpensive and reasonably effective for cleaning the male form of a fiber-optic connector. While inconvenient, the commercial market will typically disassemble a connector in order to clean the terminus on the female side. Alternatively, the supplies to clean the female side of the connection in situ (e.g., special swabs) are expensive and relatively ineffective. Therefore, a more effective means of cleaning fiber-optic connectors to avoid disassembling them is required. Military and commercial fiber-optic termini have a range of diameters (1.25 to 2.5 mm) that need to be handled. Although it is desirable to only have one apparatus to clean all sizes, multiple adapters may be required, especially if male termini are to be handled as well. Also, the cleaning head may be separated from the reservoir and delivery system in order to provide a means to clean efficiency.

The cleaner/cleaning apparatus/cleaning process for fiber-optic connectors (especially female) should be low cost, lightweight, self-contained, and small in size. It should use a solvent delivery and removal system to remove both statically attached particles as well as common water and petro-chemical based contaminants such as avionics coolant polyalphaolefin and jet fuel. It must be able to handle standard military MIL-STD-29504 termini as well as standard fiber-optic connector ferrules (1.25- to 2-mm diameter). The intent is to develop a device that is low enough in cost and easy enough to use (e.g., first level maintenance technician) to result in high-volume sales similar to air duster cans.

PHASE I: Perform a concept analysis of a cleaning technology based on cleaning efficiency, cost projections, and handleablity. Evaluate methodologies to fulfill the basic cleaning requirement that might also fulfill the handleability and cost requirements. Perform focused experimentation and prototyping to confirm the feasibility and efficiency of the selected technologies. Estimate the cost of initial and full-rate production of the solutions. Optimize the solution for a low-cost cleaner while balancing efficiency, size, and weight.

PHASE II: Develop, demonstrate, and validate the prototype technology. Evaluate the technology's ability to meet the stated requirements. Deliver two to ten prototypes at the completion of the work for Navy evaluation.

PHASE III: Transition the technology to the Navy. Address any unique requirements from a particular military prime contractor or to accommodate any new changes in connector technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: If successful, this topic will develop a connector cleaner that is both effective at cleaning female connectors and low enough in cost that it will be considered a consumable item for fiber-optic cable plant maintenance. The private sector is utilizing female connectors with ever increasing application. The problem of cleaning them continues grow. When successful, this cleaner should see application throughout the fiber-optic industry.

REFERENCES:

1. Lytle, Steve. "Cleaning of Fiber Optic Connectors." Westover Scientific, NFOWG III, Jacksonville, Florida, April 8, 2003.

2. MIL-DTL-38999, Connectors, Electrics, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for, dated 22 August 2003.

3. MIL-C-28876, Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for, 04 May 1995.

4. MIL-STD-29504, Termini, Fiber Optic Connector, Removable, General Specification for, 12 November 2002.

5. MIL-PRF-87252C, Coolant Fluid, Hydrolytically Stable, Dielectric, General Specification for, 24 October 1997.

KEYWORDS: Fiber Optics; Connector; Cleaning; Communications; Ferrules; Maintenance

N04-255 TITLE: Maintainer Head and Hearing Protection

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop advanced lightweight head protection technology compatible with advanced hearing protection.

DESCRIPTION: Head protection is worn on the flight deck and flight line during launch and recovery operations for up to 16 hours at a time. The current head protection was designed in the 1950's, is modular in design, and uses a circum-aural passive hearing protector consisting of an ear cup assembly with an ear seal or cushion. The head protection comes in four different sizes in the non-communication version and one size in the communication version. Both versions are very difficult to clean; are a source of high heat build up; are uncomfortable to wear; and are not compatible with night vision devices (NVD) or chemical, biological, and radiological (CBR) equipment. Parts of the existing flight deck helmet have also been a source of foreign object damage (FOD). The working conditions on and around aircraft often lead to personnel falling from the aircraft or striking their head on various aircraft and support equipment parts due to their close proximity in the working environment. Cranial injuries may also occur as a result of impact from rotating propellers or rotor blades.

New, innovative lightweight head protection technologies are sought that will provide cranial impact protection. They must also be compatible with advanced electronic hearing protection technology being developed for personnel performing maintenance and aircraft launch and recovery operations while working in high noise hazard areas on the decks of aviation capable ships and flight lines ashore. Proposed solutions should provide improved fit with minimal sizing and ease of maintenance to include simplified cleaning procedures, donning and doffing. The proposed solutions should also provide peripheral vision of greater than 120 degrees, and be compatible with NVD devices, CBR equipment, and electromagnetic interference (EMI) generated by ship or aircraft avionics. They should also be adaptable to a wide variety of color-coding and passive signal materials and environmentally stable to provide user comfort within a diverse range of temperatures and operating conditions. In addition, no part of the head protection technology should become a FOD source.

PHASE I: Develop an initial design concept and demonstrate the feasibility of the proposed technology to verify the concept. Investigate the weight, cost, and environmental effects, as well as materials, manufacturing, and logistic support considerations. Navy personnel will provide one of each size of the deck crew helmet (non-communication version) and Navy flight deck survey data to the Phase I contractor(s).

PHASE II: Develop, demonstrate, and validate the prototype head protection technology. Evaluate the unit's ability to perform as required by the operations analysis. Refine the design of the head protection technology as needed, based on the results of the development testing.

PHASE III: Complete Fleet testing of the prototype and transition the head protection technology to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Foreign military sale (FMS) maintenance personnel operating in and around aircraft are in need of this head protection technology. This head protection technology can also be used for aircraft passenger head protection in military aircraft. It could also produce advanced improvements for automobile crash protection, sports injury protection, and crash impact protection for the general aviation industry.

REFERENCES:
1. SAE-AS23899; Aural Protector Sound.

2. ASA Z24.22-1957; American Standard Method for the Measurement of Real-Ear Attenuation of Ear Protectors.

3. MIL-H-81735B(AS); Helmets, Flight Deck Crewman's, Impact Resistant.

4. MIL-G-43914D; Goggles, Sun, Wind and Dust.

5. L-P-1183B; Plastic Molding Material, Acrylonitrile-Butadiene-Stryene (ABS) Rigid.

6. Helmet Advanced Technology Laboratory Test Report, # HATLAB 0195 of 27 Jan 1995, Impact Performance Comparison of HGU-25(V)2/P Flight Deck Helmet and Pro-Tec Whitewater Helmet.

7. NATC Patuxent River MD Technical Report ST35-52R-63, Service Evaluation of Flight Deck Helmet and Sound Attenuating Devices, Third Interim Report, 6 September 1963.

8. Technical Manual TM 6260.51, Navy Occupational and Environmental Medicine Hearing Conservation Program.

9. ANSI.S12.42-1995 [R1999] American National Standard Microphone-In-Real-Ear and Acoustic Test Fixture Methods for the Measurement of Insertion Loss of Circumaural Hearing Protection Devices.

10. "Acoustical Noise Fields Generated on the Deck of the USS Nassau During Shipboard Operations of AV-8B Aircraft." Technical Report # NAWCADPAX/TR-2000-208, 26 February 2001.

11. "Acoustical Noise Fields Generated on the Deck of the HMS Invincible During Shipboard Operations of FA2 Harrier Aircraft." 5 February 2003.

12. "Measurement of AV-8B Cockpit Noise." 30 September 2003.

13. "Acoustical Noise Fields Generated on the Deck of the Flight Deck During Operations of F/A-18C/D, F-14B, EA-6B and S-3B Aircraft." 24 September 2002.

14. 750 3D USN Maintainer/Aviator Anthtropometry Headscans in IGES file format.

KEYWORDS: Maintenance; Head Support; Head Protection; Personnel Protective Equipment; Safety; Hearing Protection

N04-256 TITLE: Wireless Sensors with Advanced Detection and Prognostic Capabilities for Corrosion Health Management

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop, integrate, and demonstrate wireless corrosion sensors and algorithms capable of detecting, monitoring, and predicting the corrosion health (damage) of aircraft.

DESCRIPTION: The JSF Corrosion and Control Plan seeks to minimize life-cycle costs due to environmental degradation, including deterioration of nonmetallic materials as well as corrosion of metals. The development and demonstration of the latest wireless and sensing technology and smart systems for corrosion detection and prediction will support the effective implementation of structural prognostics and health monitoring (SPHM) and the autonomic logistic information system (ALIS) within the JSF. The capability of thin-film devices to measure in-situ galvanic activity has been demonstrated. This SBIR primarily addresses the need to develop a robust and affordable wireless version of similar capability. The next step is to develop appropriate algorithms and models to relate the galvanic activity to the actual in-situ corrosion damage.

PHASE I: Develop and report on an overall strategy to develop wireless corrosion sensors and algorithms or smart systems for corrosion detection and prediction. Determine the feasibility of the proposed technology to detect and measure corrosion.

PHASE II: Develop and demonstrate a prototype of the preferred wireless sensor system, both hardware and software, for an agreed aircraft component/subsystem. Develop and validate processes, algorithms, and models to relate measured corrosion activity to in-situ corrosion damage.

PHASE III: Finalize the development of the wireless sensor system with a major aircraft and/or engine manufacturer.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Corrosion is a major life-cycle cost to both military and commercial aircraft fleets and so the successful development of a lightweight, durable, and affordable wireless corrosion sensor capable of monitoring, detecting, and predicting corrosion damage, particularly in hard to inspect or hidden areas, would have huge commercial potential and payback.

REFERENCES:
1. MIL-HDBK-1568, Material and Processes for Corrosion Prevention and Control in Aerospace Weapons Systems, dated 18 July 1996.

2. Henley, S., Currer, R., Sheuren, B., Hess, A., and Goodman, G. "Autonomic Logistics—The Support Concept for the 21st Century." IEEE Proceedings, Track 11, paper zf11_0701.

3. Byer, B., Hess, A., and Fila, L. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics." Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095-3103.

4. SAE E-32 Committee Documents. http://forums.sae.org/access/dispatch.cgi/TEAE32_pf/showFolder/100001/def/def/3f4f

5. IEEE Aerospace Conference Proceedings for 2001 and 2002 Track 11 PHM.

KEYWORDS: Condition Based Maintenance; Corrosion, Wireless Sensors; Prognostics; Health Management; Logistics

N04-257 TITLE: Enhanced Rotorcraft Aerodynamic Modules to Support Flight Testing

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: PMA-274, Presidential Helicopter Program

OBJECTIVE: Develop enhanced rotorcraft dynamic blade stall, rotor tip, and high rate of descent modules to improve flight-testing support.

DESCRIPTION: Rotorcraft are used for a variety of mission tasks including low- and high-speed flight operations in land and sea environments. Predicting performance is important in analytically determining which maneuvers can be performed under a specified set of operational conditions. Accurate power requirement predictions are especially important for the rotorcraft task where insufficient power could preclude a safe landing and/or maneuver. Improved models are also required to predict rotor blade stall characteristics accurately in combined low speed and high rate of descent flight conditions. Modern helicopter analytic codes have made progress and currently have the capability to run elastic blade element models in either non-real or real time. These comprehensive codes are very limited in their ability to support rotorcraft blade stall testing, high rate of descent testing, downwash testing, and rotorcraft/ship dynamic interface testing. Downwash testing of a modern tilt rotor aircraft can be very costly, and the testing is conducted with instrumentation that cannot make three-dimensional volumetric measurements. Downwash models have difficulty in predicting the pulsating character of the rotorwash. Modern analytic codes address various blade retention systems and blade airfoil section types at every blade location except at the blade tip. A constant factor, the so-called tip loss factor of .97, is typically used in main rotor preliminary design, modeling, and performance calculations. A factor of .92 is often used in modeling and performance calculations for the tail rotor. Time-dependent tip loss formulas provide improved results in forward flight. Several variations of tip loss formula have been developed, and inconsistencies have been documented. An enhanced helicopter rotor dynamic stall, rotor tip, and downwash analysis capability is needed to help support flight envelope development for rotorcraft land- and ship-based testing and for low-speed ground and flight operational analysis.

PHASE I: Define the status of blade stall, blade tip, high rate of descent, and downwash modeling in current comprehensive real-time and non-real-time codes that could be used to support rotorcraft flight testing. Define a plan to develop enhanced rotor stall, rotor tip, and high rate of descent and downwash analytic modules. Develop an initial demonstration that shows the potential to predict the three-dimensional forces and moments for various blade tip shapes, rotor geometry, blade azimuth, rotor configurations, airspeed, and rate of descent for various rotor wake inflow conditions as a function of ground and flight condition with external disturbances.

PHASE II: Develop enhanced physics-based downwash, rotor tip, and rotor stall modules and validate the modules using available empirical, analytical, wind tunnel, whirl stand, or other experimental data. Apply the modules to specified rotorcraft and demonstrate their ability to support hover/low-speed ground and flight operations, high descent rate (including vortex ring state) testing, and helicopter/ship dynamic interface testing. Demonstrate how the modules could be validated and incorporated in a real-time simulation to support flight-testing.

PHASE III: Apply the enhanced rotorcraft downwash, rotor tip, and rotor stall modules to specific Army rotorcraft codes to improve their ability to predict multi-Service rotorcraft performance or for future multi-Service rotorcraft preliminary design programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The enhanced downwash, rotor tip, and rotor stall analytic modules could be used to improve commercial rotorcraft codes used for various analysis options. Accurate blade stall, downwash, and performance predictions are required from both safety and fiscal perspectives.

REFERENCES:
1. Bousman, William G. "A Qualitative Examination of Dynamic Stall from Flight Test Data". American Helicopter Society 53rd Annual Forum, Virginia Beach, VA, April 1997.

2. Ferguson, Samuel W. Rotorwash Analysis Handbook, DOT/FAA/RD-93/31, I & II, June 1994.

3. Peters, D., and Chiu, Y.W. "Extension of Classical Tip Loss Formulas." Journal of the American Helicopter Society, Vol. 34 - No. 2, April 1989.

4. Wood, E., Kolar, R., and Cricelli, A. "A Time-Dependent Tip Loss Formula for Rotor Blade Dynamic Analysis," Paper No. 91-57, 17th European Rotorcraft Forum, Berlin, Germany, 24-26 September 1991.

5. Prouty, R. "New Questions About Tip-Loss Factor." Rotor & Wing Magazine Aerodynamic, June 1993.

6. Prouty, R. " Tip-Loss Factor in Forward Flight." Rotor & Wing Magazine Aerodynamic, August 1993.

7. Prouty, R. " Keeping Blade Stall at Bay." Rotor & Wing Magazine Aerodynamic, August 1994.

KEYWORDS: Rotorcraft; Downwash; Tip Loss; Rotor Stall,; Rotor Geometry; Wake Geometry

N04-258 TITLE: Advanced Fault and Failure Anomaly Detection Technologies to Support Enhanced Prognostics and Health Monitoring (PHM) Capabilities

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop innovative technologies, including models, techniques and decision support tools that would enhance PHM capabilities in the area of fault and failure anomaly detection of air vehicle avionic electrical components and systems.

DESCRIPTION: In order to fully enable the JSF vision for Autonomic Logistics, there is a requirement for improved fault isolation technologies to cover the various air vehicle avionic electrical components, systems, and sub-systems. Innovative technologies may be of generic application or focus on specific component elements, or seek to integrate to a specific sub-system or higher system level. The focus should be on the development of physics models and techniques that deal with anomalies in these systems and the appropriate associated sensors. Difficult or complex problem areas may require the development of new sensors. However, because new sensors can pose cost and weight penalties, innovative ways of employing and verifying existing sensors to provide fault and failure anomaly detection should be examined as well. This effort will develop, demonstrate, and apply advanced detection technologies in support of PHM.

PHASE I: Define the technologies, techniques, and processes to be used to detect and isolate faults, and the avionic electrical, sub-systems or components to be addressed. This will include the identification of physics models and the associated algorithms that process anomalies, sensor selection and data acquisition system identification. Develop a strategy for integrating the required detection technologies within a comprehensive PHM system with considerations given to minimal weight, size, cost, and power consumption. Demonstrate the feasibility to develop the proposed models, sensors, techniques, and software into a proven architecture.

PHASE II: Develop and demonstrate a prototype for the proposed anomaly detection model and apply it to aircraft avionic systems and/ or components. Fault and failure anomaly detection will be demonstrated based on these physics models and will employ new or existing sensors in parallel with accompanying algorithms and new or existing data acquisition systems which were identified in Phase I. Assess the application boundaries, accuracy, and limitations of the detection technologies.

PHASE III: Develop, validate, and deliver a complete set of physics models, algorithms and techniques for application to several aircraft avionic systems. Refine and integrate these capabilities with a comprehensive PHM system. Apply these detection technology packages to a new aircraft development program like the Joint Strike Fighter (JSF).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Improved fault and failure anomaly detection would be applicable to any electrical machine application that was applying diagnostics, prognostics, and health management capabilities. Any results (understanding) gained from applying the detection technologies, techniques, models, and decision support tools to particular electrical systems would provide a significant crossover benefit to other similar applications, commercial or military.

REFERENCES:

1. Henley, S., Currer, R., Sheuren, B., Hess, A., and Goodman, G. "Autonomic Logistics-The Support Concept for the 21st Century." IEEE Proceedings, Track 11, paper zf11_0701.

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

3. SAE E-32 Committee Documents, http://forums.sae.org/access/dispatch.cgi/TEAE32_pf/showFolder/100001/def/def/3f4f.

4. IEEE Aerospace Conference Proceedings for 2001 and 2002 Track 11 PHM.


KEYWORDS: Condition Based Maintenance; Fault Detection, Prognostics; Health Management; Logistics; Anomaly Detection

N04-259 TITLE: <u>Ni-Cad Battery State-of-Health Indication Improvements</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop sensors and algorithms to determine Ni-Cad battery state of health.

DESCRIPTION: For the purposes of this topic, state of health is defined as current state of charge, useful remaining life as a function of life cycle, and useful remaining discharge time as a function of the current discharge rate. The intent is to use sensors and algorithms to provide the aircrew and maintainers with current state of health to enhance flight safety and facilitate condition-based maintenance processes. Traditional approaches to determining Ni-Cad battery state of health have been unsuccessful for either of those intents. The operational concept is to periodically relay information to the off-board maintenance information system for trending, prognostics, and historical record keeping.

The traditional approaches have been based upon accounting for the differences between amperage or amp-hour charging and discharging. Various environmental influences (cell temperatures during charge and discharge) and specific battery design characteristics (cell voltages, leakage currents, and imbalances under load and charge) have not been taken into account and have large adverse impacts upon the accuracy of the derived state of health in actual operational environments. As a result, condition-based maintenance has never been effectively implemented for Ni-Cad batteries. Instead, batteries are routinely scheduled for deep cycle conditioning maintenance in an attempt to assure that the battery has adequate reserve capacity. Models are required that correct for environmental, battery design, and any other factors with sufficient accuracy to implement condition-based maintenance for Ni-Cad batteries for all operational environments of the targeted aircraft application. Ideally, the model should be able to be uploaded as a software modification to targeted applications without requiring hardware modifications. Compliance with specific open architecture standards should be identified.

PHASE I: Determine the feasibility of developing software models to implement condition based maintenance for Ni-Cad batteries. Analyze environmental, design, and any other known influences to determine the scope of impacts to state-of-health indications. Develop accuracy requirements to safely implement condition-based maintenance for the targeted system. Analyze the targeted battery system to determine design constraints on software models.

PHASE II: Develop correction factors for relevant environmental, design, and other known influences for state-of-health models. Demonstrate a prototype battery state-of-health model in the targeted aircraft PHM system architecture in a test bed environment. In a laboratory environment, verify that the accuracy of the state-of-health models is sufficient to implement condition-based maintenance in an operational application.

PHASE III: Incorporate the aircraft battery state-of-health indication on the targeted application in new production and existing aircraft, making any necessary modifications to the maintenance and support concepts to eliminate scheduled battery removals and replacements.

PRIVATE SECTOR COMMERCIAL POTENTIAL: An aircraft battery state-of-health system would have broad application to commercial aviation, shipping, locomotives, and possibly trucking industries.

KEYWORDS: Condition Based Maintenance; Diagnostics; Prognostics; Ni-Cad; Battery, State-of-Health

N04-260 TITLE: Embedded Wiring Diagnostic Technology for Aircraft

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-261, H-53 Helicopters; PMA-275, V-22

OBJECTIVE: Develop and package wire diagnostic technology that can be fully or partially embedded into the aircraft wiring system to manage the health of the vehicle wiring.

DESCRIPTION: Navy aircraft wiring systems have an impact on maintenance costs, safety of flight, and aircraft readiness. The Navy estimates that 5-9 percent of the 20,000,000 organizational man-hours per year are spent troubleshooting and repairing aircraft wiring. The Naval Safety Center documented 300 Navy aircraft wiring fires that caused mission aborts and four lost aircraft (TA-4J, E-2C, AV-8B and EA-6B) in the past 10 years. Logistic data indicate that 1,416 mission aborts and 249,400 non-mission capable (NMC) hours per year are attributed to wiring incidents. Wire system failures are costing millions of dollars annually in false equipment removals.

To address these problems, the Navy is developing prognostic and diagnostic technologies for aircraft wiring systems. The incorporation of wiring diagnostics will reduce the time required to isolate faulty wires, minimize erroneous equipment removals, allow for proactive replacement of aged or otherwise degraded wiring systems prior to catastrophic failure, and provide a substantial increase in safety by eliminating wiring fires. One of the Navy focus areas in wiring diagnostics, known as "smart wiring," is the development of wiring diagnostic technologies and systems that can be fully or partially embedded into the aircraft wiring system. Benefits of embedded diagnostics include, but are not limited to, the ability to detect in-flight anomalies and the capacity to be integrated with existing vehicle health management systems. Embedded diagnostics also can provide crew station status indication and minimize disturbances to the wiring system during diagnostic tests. Wiring diagnostics has applicability to both new and legacy aircraft wiring systems.

The intent of this topic is to focus innovative research on solving the technical challenges associated with embedding wiring diagnostic systems into aircraft. Technical challenges include development of a diagnostic technology that is suitable for in-flight use and meets applicable performance criteria; packaging and integrating into the aircraft wiring system including such challenges as wire system complexity, wire system interface and data transfer, and ease of interpretation of results; sensitivity of the diagnostic technique including such challenges as early detection of insulation breakdown and wire chafing, ability to distinguish defect types and severity, and ability to determine defect location; noise discrimination (EMI) and minimizing false alarm rates; being noninvasive and fail safe ("do no harm"); and meeting the Navy's unique and harsh environmental requirements.

PHASE I: Define a technical approach and develop an implementation plan for embedding wiring diagnostic technology into aircraft. Validate the approach analytically or provide test data or bench top hardware that would validate the approach.

PHASE II: Design, develop, and demonstrate the embedded wiring diagnostic system. Demonstration can include a high-fidelity laboratory environment and/or aircraft ground demonstration.

PHASE III: Package and integrate the embedded wiring diagnostic system for use in an aircraft vehicle health monitoring system. Perform a flight evaluation of the embedded wiring diagnostic system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The results of this work can be commercialized to provide diagnostic systems that can detect wire anomalies in space, sea, air, and land vehicles. This technology will result in an increase in safety and reliability for these vehicles while reducing maintenance troubleshooting times and maintenance costs. Commercial airlines are specifically interested in diagnostic technologies for aging wiring systems. Also, the results of this work can be applied to consumer products and industrial applications. The results of this work are a logical extension to the arc fault circuit interrupter (AFCI) technology that is being implemented in residential homes and commercial buildings. Other private sectors that face similar wiring degradation and safety concerns include the automotive industry and nuclear power plants.

REFERENCES:
1. Review of Federal Programs for Wire System Safety. Executive Report Issued by the Wire System Safety Interagency Working Group (WSSIWG) under the White House Office of Science Technology Policy. November 2000. http://ostp.gov/NSTC/html/nstc_pubs.html

2. Furse, Dr. Cynthia, and Haupt, Dr. Randy. "Down to the Wire, The HIdden Hazard of Aging Aircraft Wiring." IEEE Spectrum; February 2001.

3. Dornheim, Michael A. "New Rules and Hardware for Wiring Soon to Emerge." Aviation Week and Space Technology; 2 April 2001.

KEYWORDS: Wire Diagnostics; Wire Insulation; Aircraft Wiring; Condition Based Maintenance; Cables; Wiring Harnesses

N04-261 TITLE: Erosion Resistant Coatings for Shaft-Driven Compressor (SDC) Impellers

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA 275, V-22

OBJECTIVE: Develop and/or demonstrate an erosion resistant coating for SDC impellers for aircraft applications currently experiencing limited life from sand erosion.

DESCRIPTION: The Armed Services currently use SDC's on certain aircraft to provide, among other things, service to on-board inert/oxygen gas separators (OBIGS/OBOGS) and environmental control systems (ECS). Air intakes for these compressors are equipped with particle separators to prevent abrasive material from coming in contact with the impeller, which can operate from 87,000 to 100,000 revolutions per minute (nominal) at temperatures from 125 degrees F to 600 degrees F. Aircraft that might operate over sandy or dusty landing zones (LZ's) or during dust/sand storms, particularly helicopters and other vertical/short takeoff and landing (VTOL/STOL) aircraft such as the V-22 Osprey, have experienced rapid erosion of impellers, especially when the particle separator is overtaxed. This can lead to loss of function of critical components and potentially catastrophic system failures. There is a need to provide a coating for SDC impellers, currently made of titanium 6:4 alloy, which obviates the erosion phenomena to an acceptable level.

PHASE I: Develop and demonstrate an erosion resistant coating for SDC impellers for use on military aircraft. The coating and process should be compatible with shot-peened titanium (6:4) (i.e., induced compressive surface stresses should not be annealed by process), the current impeller alloy, and should significantly improve sand erosion resistance. Relative sand/impeller velocities between 1000-2000 ft/sec are typical. Sand loadings are not known at this time but are an important factor in impeller/coating life and can be provided by the Navy at time of testing. Use realistic simulations of the fielded environment to test the proposed coating technology and demonstrate a significant benefit over the baseline Titanium metal. demonstrated.

PHASE II: Perform component level sand-erosion testing in an actual compressor of promising coatings demonstrated during Phase I.

PHASE III: Scale-up for production quantities and transition the process to the Fleet through specification modifications and revisions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A successful coating can be used for SDC impellers for commercial aircraft as well as DOD aircraft and can transition to any other activities needing improved erosion resistant surfaces.

REFERENCES:
1. Richardson, G. Y., Lei, C. S., and Tabakoff, W. "Erosion Testing of Coatings for V-22 Aircraft Applications." NAVAIR Report XX-SSS-04 (to be published).

2. Peachman, D. "Shaft Driven Compressor Failures Briefing." Bell Helicopter Textron, Inter-Office-Memo, JCV:hrm-98-17, 27 October 1998.

3. Peachman, D. "SDC Go-Forward Plan." Bell/Navy/Allied Signal Meeting, Patuxent River, Maryland, June 25, 1999.

4. Tabakoff, W. "A Study of the Surface Deterioration Due to Erosion." ASME Journal of Engineering for Power, October, 1983, p. 834.

5. "The Influence of Coating Processes and Process Parameters on Surface Erosion Resistance and Substrate Fatigue Strength." Surface and Coating Technology, 36, 1988, p. 433.

KEYWORDS: Erosion; Impeller; Coatings; Titanium; Shaft-Driven Compressor; Sand; Particle Separation

N04-262 TITLE: Automated Nondestructive Evaluation (NDE) System for Finding Foreign Materials and Contaminants in Manually Fabricated Composite Components

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA-275, V-22

OBJECTIVE: Develop new innovative technologies or processes that would substantially reduce the inspection time to detect foreign materials and contaminants in thick manual lay-ups for composite components.

DESCRIPTION: The cost associated with scrap/rework of composite components having foreign inclusions and contaminant-induced defects is well documented. Insertion of detection/inspection technology capable of detecting foreign materials and contaminants during the fabrication process will reduce these costs. Manual lay-ups for composite (fiberglass, graphite or a comination of the two) components are up to 5 inches thick. Innovative semi-automated or automated processes are sought that are capable of detecting a wide variety of foreign material and contaminants such as metal (steel, aluminum, etc.) polymers, ceramics, wood, and paper in the composite lay-up. Proposed solutions should be able to detect foreign material and contaminates while the component is laying in a steel mold or wrapped on a steel mandrel. The proposed systems should not contact the composite material with a tool or any kind of couplant as the composite material is in the uncured state. The inspection system will be operated on a factory floor and must not have any environmental or safety impact on nearby workers.

Insertion of this tecnology in the fabrication process (for example, prior to debulking) will enable correction by de-ply and should reduce the defect population including foreign materials. Savings in cycle time and labor hours due to reduction of defects would be substantial. Substantial costs associated with custom application of traceable backing materials (i.e., aluminized) could be eliminated.

PHASE I: Demonstrate the scientific merit and feasibility of detecting foreign materials in composite lay-ups. The inspection process must not contact the composite or require removal of the composite from the metal manufacturing tooling.

PHASE II: Develop and optimize the proposed technology for the variety of composite material types, combinations, thickness ranges, and tooling configurations. Demonstrate a working prototype under expected manufacturing floor conditions.

PHASE III: Refine the user interface and adapt the system for specific application(s). Develop an operating scenario and obtain feedback so that the optimization criteria are formulated and applied. Ensure that beneficial data from the system are efficiently routed, displayed, or recorded. Mitigate reliability issues.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology will be most applicable to the manual lay-up process for composite manufacturing such as that found in the aircraft or rotorcraft industry. It may also be applied to ship building and civil infrastructure as well.

REFERENCES:
1. Harrouche, K., Rouvaen, J. M., Duquennoy, M., Ourak, M., and Ouafthouh, M. "Comparative Study of Processing Methods for Analyzing the Structure of Carbon Epoxy Composite Materials." American Institute of Physics, Vol. 509, pp. 1191-1198.

KEYWORDS: NDE; NDI; Nondetructive Testing; Inspection; Composites; Hand Layup

N04-263 TITLE: Advanced Multi-Band Electronic Surveillance Measure (ESM) Antenna

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-263, Navy Unmanned Aerial Vehicles Program

Acquisition Sponsor: PMA-263, Navy Unmanned Aerial Vehicles Program

OBJECTIVE: Develop a multi-band, lightweight ESM antenna capable of being installed on multiple, unmanned air vehicle (UAV) platforms.

DESCRIPTION: The numerous antenna systems that are currently required to provide effective coverage for existing ESM systems are very difficult to integrate on UAV's due to excessive space and weight requirements. Increased complexity of multiple antenna systems increases nonrecurring engineering (NRE) costs and creates logistic difficulties for supporting the multiple antenna systems.

Revolutionary antenna technologies are sought that will be lightweight, provide a wide area radio frequency (RF) coverage, and be capable of interfacing with existing and planned UAV ESM/electronic intelligence (ELINT) systems. Preserving the gain and coverage characteristics of multiple antennas in a single integrated package is technically challenging and the core of this effort. It will require advancing the state of the art in antenna design. Its lightweight and modest size will enable it to be used on a large family of UAVs from tactical to strategic. If successful, the technology has potential for use on Air Force Global Hawk, Predator, Fire Scout, Aerial Common Sensor (ACS), EP-3 and other intelligence, surveillance and reconnaissance (ISR) platforms.

PHASE I: Perform a feasibility study and demonstrate the antenna technology proof of concept. Define the system/antenna interface requirements.

PHASE II: Develop, demonstrate, and validate a prototype model. Test using existing ESM/ELINT equipment. Validate the prototype on a Global Hawk Maritime Demonstration (GHMD) asset.

PHASE III: Demonstrate the operational utility of the antenna in Fleet exercises using the Navy's GHMD assets.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This antenna system could be used by any commercial user seeking wideband spectrum coverage. It could prove most useful when used in conjunction with current and planned multi-band radios.

KEYWORDS: Surveillance; Recognizance; Signal Intelligence; Electronic Intelligence; Wide Band; Modularity

N04-264 TITLE: <u>Automated Software Architecture Analysis and Visualization Advanced of Large, Mixed-Language Systems</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMA-282, Surface Ship Cruise Missile Weapon Systems

OBJECTIVE: Devise an innovative concept for automated analysis and visualization of the architecture of a large, mixed language software system.

DESCRIPTION: The Tactical Tomahawk Weapon Control System (TTWCS) and a multitude of military systems are following an evolutionary, spiral development pattern in which millions of lines of source code are modified over a period of ten or more years to support new capabilities and to fix defects. For example, the baseline TTWCS software is currently composed of 1.2 million lines of Ada, C, C++ and standard query language (SQL) code, in addition to Unix scripts.

TTWCS is a large, complex software system whose software architecture will evolve over time. Like other large complex software systems, its software architecture is imperfectly known. An abstract model that could be extracted from the TTWCS source code in an automated fashion, visualized, and mapped to the source code would be an aid to software engineers as they plan architecture and design changes for upgrades. This is beyond the current state of the art.

This SBIR topic seeks to advance the state of the art in automated software analysis and visualization of the software architectures of large complex systems implemented in multiple programming languages. This requires automated construction of an abstract model from mixed language source code. Initialization of this construction process and related interaction with the users (software engineers) are acceptable if this improves the analysis but is not made burdensome. The model must be of practical use to software engineers, accurately mapped to the source code, and organized such that it is amenable to separations of concern in the architecture. Advanced visualization techniques must be applied to communicate the model to software engineers in such a way that supports their decision-making and design planning for upgrades, as well as simple improvements in the architecture. Prototypical capabilities should include the ability to easily, quickly, and intuitively browse and search analysis results and the model itself.

PHASE I: Develop an innovative technology for analyzing in an automated fashion and visualizing software architectures of large, complex, and mixed programming language software systems. Demonstrate the technical merit of the proposed solution.

PHASE II: Implement and demonstrate a prototype of the innovations developed in Phase I. The prototype should be capable of analyzing a minimum of 600,000 lines of code in multiple programming languages, including Ada and C++, presenting a visualization of the software architecture model, and allowing the user to quickly browse and search analysis results and the model. The prototype's architecture should be extendable to future incorporation of advanced software reengineering optimization aids based on such methodologies.

PHASE III: Mature the prototype capability for use in reengineering the TTWCS software where required during upgrades and to support integration of existing software components into the TTWCS.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial world is faced with the same issue --- reengineering large software systems over a long period of time and adapting large-scale components to new uses. In particular, this will be important for the transportation, energy distribution, communications, banking and health care industries as they increasingly utilize large software systems for critical functions and those systems evolve over time. As software evolves, it often loses its modularity, which impacts it maintainability.

REFERENCES:
1. Sullivan, K., Griswold, W. G., Cai, Y., and Hallen, B. "The Structure and Value of Modularity in Software Design." University of Virginia Department of Computer Science Technical Report CS-2001-13, submitted for publication to ESEC/FSE 2001.

2. Clarke, Siobhán, and Walker, Robert J. "Separating Crosscutting Concerns Across the Lifecycle: From Composition Patterns to AspectJ and Hyper/J." Technical Report TCD-CS-2001-15 and UBC-CS-TR-2001-05.

3. Robillard, Martin P., and Murphy, Gail C. "Concern Graphs: Finding and Describing Concerns Using Structural Program Dependencies." ICSE 2002.

4. Jackson, Daniel, and Rinard, Martin. "Software Analysis: A Roadmap." The Future of Software Engineering, Editor Anthony Finkelstein, ACM Press, June 2000.

5. Jackson, D., and Sullivan, K. J. "COM Revisited: Tool-Assisted Modeling and Analysis of Complex Software Structures." SIGSOFT 2000, ACM SIGSOFT International Symposium on the Foundations of Software Engineering, November 2000.

6. Sullivan, K. J., Chalasani, P., Jha, S., and Sazawal, V. "Software Design as an Investment Activity: A Real Options Perspective." Real Options and Business Strategy: Applications to Decision Making, L. Trigeorgis, Consulting Editor, Risk Books, December 1999.

7. Moskovics, Stuart. "Multi-Language Support in a Program Analysis and Visualization." M.S. Thesis, Technical Report CS2000-0655, Department of Computer Science and Engineering, University of California, San Diego, June 2000.

8. Hayes, J., Griswold, W. G., Moskovics, S. "Component Design of Retargetable Program Analysis Tools that Reuse Intermediate Representations." Proceedings of the 2000 International Conference on Software Engineering, (ICSE 2000), Limerick, Ireland, June 2000.

9. Kataoka, Y., Ernst, M. D., Griswold, W. G., and Notkin, D. "Automated Support for Program Refactoring Using Invariants." 2001 International Conference on Software Maintenance (ICSM'01), November 2001, pp. 736-743.

KEYWORDS: Software Reengineering; Automated Software Analysis; Software Engineering; Software Architecture; Software Modularity; Software Modeling

N04-265 TITLE: Miniature GPS Antenna System

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA 231, PMA 263, PMA 290, PMA 299

OBJECTIVE: Develop the materials technology for miniaturization of microstrip patch anten-nas for Global Positioning System (GPS) applications

DESCRIPTION: Due to very low broadcast power of the GPS satellites, GPS signals are sus-ceptible to jamming. The most effective performance improvements against jamming are pro-vided through the use of controlled radiation pattern antennas (CRPA). Current CRPAs employ 7-8 elements and are over 13' wide in diameter. Because of the ubiquitous use of these GPS an-tennas, there is a strong interest exists to reduce their real estate requirements by 50% or so. Re-cent developments on miniature antennas under the DARPA metamaterials program [1] using new substrates allows for significant size reduction without gain and bandwidth compromise as compared to the typical large size printed antennas.

Newly developed dielectrics can allow for an area reduction by a factor of 5-10 and still deliver a good gain (single element). Previous straightforward use of high contrast dielectrics was known to cause significant bandwidth shrinkage and gain degradation. The new substrates provide the means to overcome gain reduction with size. Assuming a $3\lambda/8$ separation among the elements, these new miniature antennas can possibly reduce the overall antenna system size down to 4-6 inches or so, i.e. by a factor of 2 or more. In addition, significant weight reduction is possible by as mach as a factor of 4.

PHASE I: Demonstrate the use of meta-materials technology for GPS antenna systems. A design methodology should be established for materials design. A prototype antenna should be built and validated via measurements. Performance of the miniaturized antenna on the overall GPS system (for anti-jamming etc) needs to be established.

PHASE II: Improve size and weight reductions of the antenna systems based on the material designs in Phase I. Build a complete GPS system with miniaturized antenna system and validate the performance as compared to the conventional GPS system.

PHASE III: Miniature GPS system should be demonstrated for air or sea platforms. A rugged miniature antenna system needs to be developed as per the MIL standards.

PRIVATE SECTOR USE OF TECHNOLOGY: GPS is becoming increasingly popular in automobiles and for other personal uses. Use of a miniature GPS antenna system with anti-jamming capability could be of immense commercial use for integrating into personal vehicles, personal digital assistants etc.

REFERENCES:
1. http://www.darpa.mil/dso/thrust/matdev/metamat.htm

2. IEEE Antennas and Propagation Transactions, Special Issue on Metamaterials 2003 (to ap-pear)

KEYWORDS: GPS antennas; anti-jam antennas; miniaturized antennas; metamaterials; array size reduction; array weight reduction