NAVY
SBIR FY09.3 PROPOSAL SUBMISSION INSTRUCTIONS

The responsibility for the implementation, administration and management of the Navy SBIR Program is with the Office of Naval Research (ONR). The Director of the Navy SBIR Program is Mr. John Williams, john.williams6@navy.mil. For general inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8:00 am to 5:00 pm ET). For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed under each topic on the Web site before **24 August 2009.** Beginning 24 August, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in section 1.5c of the program solicitation must be used for any technical inquiry.

TABLE 1: NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT

Topic Numbers	Point of Contact	Activity	Email
N093-160 thru N093-163	Mr. Paul Lambert	MARCOR	sbir.admin@usmc.mil
N093-164 thru N093-186	Mrs. Janet McGovern	NAVAIR	navair.sbir@navy.mil
N093-187 thru N093-217	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N093-218 thru N093-227	Ms. Summer Jones	SPAWAR	summer.m.jones@navy.mil

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. Companies are encouraged to address the manufacturing needs of the Defense Sector in their proposals. Information on the Navy SBIR Program can be found on the Navy SBIR Web site at http://www.onr.navy.mil/sbir. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the Web site at http://www.navy.mil.

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at www.dodsbir.net/solicitation for program requirements and proposal submission. Cost estimates for travel to the sponsoring activity's facility for one day of meetings are recommended for all proposals and required for proposals submitted to MARCOR, NAVSEA, and SPAWAR. The Navy encourages proposers to include, within the 25 page limit, an option which furthers the effort and will bridge the funding gap between Phase I and the Phase II start. Phase I options are typically exercised upon the decision to fund the Phase II. For NAVAIR topics N093-164 thru N093-186 the base amount should not exceed $80,000 and 6 months; the option should not exceed $70,000 and 6 months. For all other Navy topics the base effort should not exceed $70,000 and 6 months; the option should not exceed $30,000 and 3 months. **PROPOSALS THAT HAVE A HIGHER DOLLAR AMOUNT THAN ALLOWED FOR THAT TOPIC WILL BE CONSIDERED NON-RESPONSIVE**.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in section 4.2 of the DoD solicitation in descending order of importance with technical merit being most important, followed by the qualifications, and followed by commercialization potential. 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.

One week after solicitation closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, e-mail addresses on the proposal coversheets must be correct

The Navy typically awards a firm fixed price contract or a small purchase agreement for Phase I.

PHASE I SUMMARY REPORT

In addition to the final report required in the funding agreement, all awardees must electronically submit a non-proprietary summary of that report (and without any proprietary or data rights markings) through the Navy SBIR Web site. Following the template provided on the site, submit the summary at: http://www.onr.navy.mil/sbir, click on "Submission", and then click on "Submit a Phase I or II Summary Report". This summary will be publicly accessible via the Navy's Search Database.

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. 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 Technical Point of Contact for the contract and to the appropriate Navy Activity SBIR Program Manager listed in Table 1 above. 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 GUIDELINES

Phase II proposal submission, other than Fast Track, is by invitation only. If you have been invited, follow the instructions in the invitation. **Each of the Navy Activities has different instructions for Phase II submission. Visit the Web site cited in the invitation to get specific guidance before submitting the Phase II proposal**.

The Navy will invite, evaluate and select Phase II proposals using the evaluation criteria in section 4.3 of the DoD solicitation in descending order of importance with technical merit being most important, followed by the qualifications, and followed by commercialization potential. 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.

Under the new OSD (AT&L) directed Commercialization Pilot Program (CPP), the Navy SBIR Program will be structuring more of our Phase II contracts in a way that allows for increased funding levels based on the projects transition potential. This will be done through either multiple options that may range from $250,000 to $1M each, substantial expansions to the existing contract, or a second Phase II award. For currently existing Phase II contracts, the goals of the CPP will primarily be attained through contract expansions, some of which may significantly exceed the $750,000 recommended limits for Phase II awards not identified as a CPP project. All projects in the CPP will include notice of such status in their Phase II contract modifications.

All awardees, during the second year of the Phase II, must attend a one-day Transition Assistance Program (TAP) meeting. This meeting is typically held in the summer in the Washington, D.C. area. Information can be obtained at http://www.dawnbreaker.com/navytap. Awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary (without any proprietary or data rights markings) through the Navy SBIR Web site at the end of their Phase II.

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 have 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 year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

The Navy typically awards a cost plus fixed fee contract or an Other Transaction Agreement for Phase II.

PHASE II ENHANCEMENT

The Navy has adopted a Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Public Law (PL102-564, PL111-10) permits Phase III awards during Phase II work, the Navy may match on a one-to-four ratio, SBIR funds to funds that the company obtains from an acquisition program, usually up to $250,000. The SBIR enhancement funds may only be provided to the existing Phase II contract. If you have questions, please contact the Navy Activity SBIR Program Manager.

PHASE III

Public Law 106-554, Public Law 111-10 and the 2002 Small Business Innovation Research Program Policy Directive (Directive) provide for protection of SBIR data rights under SBIR Phase III awards. Per the Directive, a Phase III SBIR award is any work that derives from, extends or logically concludes effort(s) performed under prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Thus, 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 is a Phase III SBIR contract. 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, which includes according SBIR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). The government's prime contractors and/or their subcontractors shall follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect rights of the SBIR company.

ADDITIONAL NOTES

Proposals submitted with Federal Government organizations (including the Naval Academy, Naval Post Graduate School, or any other military academy) as subcontractors will be subject to approval by the Small Business Administration (SBA) after selection and prior to award.

Any contractor proposing research that requires human, animal and recombinant DNA use is advised to view requirements at Web site http://www.onr.navy.mil/sci_tech/ahd_usage.asp. This Web site provides guidance and notes approvals that may be required before contract/work may begin.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

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

____1. Make sure you have added a header with company name, 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 am ET, 23 September 2009.

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

____4. For NAVAIR topics N093-164 thru N093-186, the base effort does not exceed $80,000 and 6 months and the option does not exceed $70,000 and 6 months. For all other proposals, the Phase I proposed cost for the base effort does not exceed $70,000 and 6 months and for the option $30,000 and 3 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 SBIR 093 Topic Index

N093-160	Protective Suit Environmental Control System for CBRN, Hazardous and Emergency Responder Applications (PSECS)
N093-161	Next Generation Helmet System
N093-162	DoD Engine Efficiency Enhancement Technology
N093-163	Innovative Heat Source Concepts for Field Food Service Equipment
N093-164	Optical Aperture Gating for Single-pixel and Imaging LIDAR Systems
N093-165	Optimal Autorotative Profiles Using Active Inceptor Cueing
N093-166	Adjusted Nitrogen Alloyed Stainless Steel with Optimized Thermal Processing for Superior Balanced Performance
N093-167	Automated Marine Mammal Mitigation Sensor for Multi-Static Active ASW
N093-168	Target Localization Using Multi-Static Sonar with Drifting Sonobuoys
N093-169	Composite Airframe Damage Detection and Evaluation
N093-170	Spline Health Prognosis via Physics Based Modeling Coupled with Component Level Tests
N093-171	Innovative Approaches for Enhancing Interlaminar Shear Strength of Two-Dimensional (2D) Composite Reinforced Flexbeams and Yokes
N093-172	Compact Energy Harvesting Power Supporting an "A" size Sensor
N093-173	Dielectric Resonator Antenna
N093-174	Nondestructive Detection of Fiber Waviness in Laminates
N093-175	Innovative Materials for Highly Loaded Wear Application in Arresting Gear Tailhook Components
N093-176	Wire Restraint Devices
N093-177	Advanced Data Compression Algorithm and Compressor-Decompressor (CODEC) Offload Engine for Aircraft Launch and Recovery Equipment (ALRE) Health Monitoring Support
N093-178	Innovative Concepts for Lightweight, Low-Cost, High Temperature Turbine Components
N093-179	Ceramic Matrix Composite Parts Marking
N093-180	Corrosion Resistant Non-Toxic Coatings for High-Strength Arresting Gear Tailhook Components
N093-181	Thrust Measurement Model for Engine Test Cell Environment
N093-182	Multi Directional Low Airspeed Indicator for Rotary Wing Aircraft
N093-183	Innovative Foreign Object Damage (FOD) Detection and Identification Technology for Military Turbine Engines
N093-184	Innovative Bearing Concepts For High Speed Rotating Machines
N093-185	Robust Pressure Transducer for Propulsion Control Systems
N093-186	MH-60S Vertical Replenishment Object Proximity Warning System
N093-187	Innovative manufacturing processes and materials for affordable Transmit/Receive (T/R) module Production
N093-188	Image Fusion for Submarine Imaging Systems
N093-189	Smart Power Load-Leveling Control for Energy Efficient, Advanced Distribution Systems
N093-190	Opportunistic Energy Harvesting
N093-191	Multi-Material Structures
N093-192	Real-time decision aid for enhancing ship’s self-defense
N093-193	Shared Situation Awareness (SSA) Measurement
N093-194	Universal Atmospheric Contaminant Scrubber for Submersibles
N093-195	Long Life Energy Storage Systems for Shipboard Sensor Applications
N093-196	Secure Open Architecture Open System Technologies for Tactical Networks
N093-197	Improved Safety in Large Format Lithium-Ion Cells and Batteries
N093-198	Sonar Detection / Classification Based on Material Identification
N093-199	Increased Submarine RF Capacity for Sensors and Surveillance
N093-200	Higher Temperature passive components, integrated circuit elements for Transmit/ Receive (T/R) Modules

N093-201	Band Limited Pulse Encoding and Signal Classification
N093-202	Innovative Damping Technologies
N093-203	Implosion-Proof SOF Mission Equipment Storage Container
N093-204	Synthetic Elements for Moving Line Arrays
N093-205	Non-contact sea water optical attenuation meter
N093-206	Compact Dipping Sonar for Unmanned Surface Vehicles (USVs)
N093-207	Innovation for Application of Unmanned Station-Keeping Sea Surface Platforms
N093-208	Innovative Coatings for Prevention of Inter-Granular Corrosion in Sensitized 5000 Series Aluminum Alloys
N093-209	Manufacturing and materials for Radar/EW Power System Stability
N093-210	Determining the Depth of Penetration During Submerged Arc Welding
N093-211	High Channel Count Optical Slip Ring
N093-212	Non-Hermetic Passivation/Coating Processes with Integrated Electromagnetic Protection
N093-213	Real-Time Hull Shape Monitor
N093-214	At-sea Reliability with Predictive Modeling
N093-215	Multi-Platform Active Heave Compensation System
N093-216	Magazine Lightweight Synthetic Decking
N093-217	Manycore, Resource Management, Dynamic/Static Application Analysis
N093-218	Orthogonal Frequency-Division Multiplex (OFDM) Waveform Optimized for Power Limited Line of Sight (LOS) User Environments
N093-219	Network Operations (NetOps) Data Transport Optimization Engine
N093-220	Ultra Low PIM Diplexer
N093-221	Highly Efficient Transmitter for High Peak to Average Power Ratio (PAPR) Waveforms
N093-222	Memristor Implementation in Software Defined Radio Hardware Architecture
N093-223	Low Cost Orbital Debris Removal System
~~N093-224~~	~~Forward Observer Automated Target Detection and Acquisition Software~~
N093-225	Cross-layer Queue Management and Queue-status Messages for Wireless Tactical Networks
N093-226	New Materials/Process for Space Qualified Electronic Components
N093-227	Automated Analysis and Verification of Application Program Interfaces (APIs)

NAVY SBIR 093 Topic Descriptions

N093-160 TITLE: Protective Suit Environmental Control System for CBRN, Hazardous and Emergency Responder Applications (PSECS)

TECHNOLOGY AREAS: Chemical/Bio Defense, Human Systems

ACQUISITION PROGRAM: Product Group 16, ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Objective: This topic seeks technology to provide an innovative, lightweight personal cooling and/or dehumidification system for Navy/Marine war fighters operating in MOPP Level 4, EOD, HAZMAT, firefighting/emergency responder and other full encapsulation/personal protective suits. The desired device should not be confused with devices targeted in widespread, unrelated previous work by various entities to provide war fighter cooling in non-encapsulation suits. This effort is geared specifically toward war fighter cooling and dehumidification while fully encapsulated, on the move and operating in a CB environment. The author is unaware of and has been unable to locate references or evidence of any prior research and development (R&D) work targeting war fighter heat and humidity reduction within the fully encapsulated environment of MOPP Level 4 operations. The system will enhance combat readiness by effectively increasing the length of time Marines can safely spend at MOPP Level 4 and by reducing the number of heat, dehydration and excessive humidity related injuries to Marines operating in MOPP and other protective encapsulation suits. The system shall be self contained and fully compatible with current personnel protective equipment and (where appropriate) battle dress uniform (BDU). The system shall be capable of sustained operation without replenishment in a chemical, biological, radiological, nuclear (CBRN) environment (2 hrs threshold, 12 hrs desired). The system shall be hardened adequately to function in the expeditionary and combat environments at least as well as the personnel protective suit with which it is used. Target design goals for the system will be to operate in ambient dry bulb temperatures of up to 125°F with humidity levels typical of the worst case desert environment. The successful system will limit micro-environment conditions within the encapsulation suits to 85F° and 50% RH with no moisture condensation. System effectiveness will be measured by comparing microclimate temperature and humidity to external environment temperature and humidity while the encapsulated war fighter performs light, moderate and heavy work. Definitions of light, moderate and heavy work will be posted on the Navy SBIR website by the TPOC shortly after topic release. The greater the reductions in dry bulb temperature and relative humidity within the encapsulated environment, the more effective the device will be determined to be. The device shall not reduce internal microclimate temperatures below 70°F and 10%RH. The system shall be light weight (5 lbs threshold, 1 lb desired) and compact (200 cubic inches total system volume threshold, less than 50 cubic inches total system volume desired), operate automatically, have a manual ON/OFF override provided, and be inherently quiet so as not to draw undue attention to user location. The system shall be easily cleaned and serviced by the user in the field with materials commonly available (such as fresh water) and require no specialized training other than brief, informal instruction on system safety and use in the CBRN environment. The system shall have no hazardous or flammable substances that would limit international air transport or require special handling at the end of system service life. The system shall tolerate standard CBRN decontamination materials and procedures or be inexpensive enough to allow for disposal and replacement after CBRN exposure. Significant creativity and the innovative blending of both new and existing technologies will be required to accomplish this task.

DESCRIPTION: Description: Due to heat build up inside Mission Oriented Protective Posture (MOPP) suits in elevated temperature environments at MOPP Level 4 (full encapsulation from head to toe for the CBRN environment), war fighters are severely limited with regard to available work time. Although The NBC Handbook (Army FM 3-7) as utilized by the USMC is distribution restricted, it can be disclosed herein and without specific details that the handbook documents an inverse relationship between ambient temperature and available work time at MOPP Level 4, particularly when combined with battle dress uniform (BDU). The handbook further documents a direct relationship between ambient air temperature and war fighter water consumption requirements to maintain adequate hydration at MOPP Level 4. Unchecked, elevated core body temperature and internal suit humidity levels degrade war fighter performance and can lead to incapacitation through dehydration, fatigue, heat stroke, humidification injuries and even death. Approximately 85% of human heat rejection is through the evaporation of perspiration. The utilization of full encapsulation and restricted airflow exchange protective suits (such as MOPP Level 4 and others) severely restricts the user''s natural evaporative cooling process, making it extremely challenging to adequately cool and dehumidify the war fighter while fully encapsulated.

In addition to heat related injuries, humidity build up within the encapsulation suits can lead to problems such as trench and tropical immersion foot syndromes. Unchecked, these serious syndromes can lead to fungal infections, war fighter incapacitation, gangrene and eventual amputation.

In short, the goal is to create an innovative, lightweight, durable, practical system to reduce the user''s core body temperature and the humidity/condensation levels within the protective suits, while operating in elevated temperature CBRN/Hazardous environments. All this must be done while placing an absolutely minimal additional burden on the user and logistics trail.

The creation and application of a lightweight, innovative cooling and dehumidification system for use with MOPP Level 4, Explosive Ordnance Disposal (EOD), HAZMAT and other unventilated personal protective suits is needed to cool the user while on the go. The creation of such a device would enhance combat readiness through maximization of available effective duty time per war fighter and provide a reduction in heat and humidity related injuries. It may be possible to provide adequate user cooling through dehumidification of the internal suit environment alone, such that the body''s natural evaporative cooling process takes over. It may also be the case that a combination of several approaches and methods is needed to effectively reduce the user''s core body temperature.

There are many unknowns. Much innovative research and development are needed. No method of adequately cooling and dehumidifying on the move war fighters in encapsulation suits currently exists. No prior R&D efforts to reduce both heat AND humidity in encapsulation suits was located by the author in an extensive literature search and interviews with USMC personnel in the CBRN operating environment. An innovative means of transferring heat and humidity from the microenvironment of the encapsulation suit to the ambient environment of the suit must be found. To do so will require innovations in materials technology, and the creation of new and better laminates and wicking agents. No suitable cooling or dehumidification products currently exist. Highly innovative applications of basic heat and humidity transfer principles will have to be utilized to create new refrigeration/dehumidification schemes and systems. No scalable refrigeration/dehumidification/heat and moisture transfer technologies currently exist to create the desired device. Indeed significant innovative technology advancements and applications will be required to create the desired system.

PHASE I: Conceptualize, evaluate and identify a design for an inexpensive, cooling/dehumidification system operable in CBRN environments that meets weight the requirement (5 lbs threshold, 1 lb desired), total system volume requirement (200 cubic inches threshold, 50 cubic inches desired), operating time (2 hrs threshold, 12 hrs desired) and contains no toxic or hazardous materials. Fabrication of a proof of concept breadboard prototype to demonstrate the technical principles involved in the solution proposed for Phase II investigation is encouraged, but not required. Deliver a final report that specifies how full-scale performance will be met in Phase II. The report shall also detail the conceptual design, performance modeling, safety, mitigation of risk, and estimated production costs.

PHASE II: From the data gained in Phase I, develop, test, and demonstrate a full scale prototype cooling/dehumidification system that meets the system requirements from Phase I. This fully operational prototype will be designed and developed for testing at the end of Phase II. The device will have minimal complexity, require no maintenance, will integrate efficiently with current PPE gear and body armor systems, account for the surface temperature of the skin/cooling system interface, and the metabolic rate of the user, clothing and environmental factors. The device will operate hands-free while on the move, require no outside power sources, and require no maintenance other than field replacement consumables. If battery power is required, batteries normally accessible through standard USMC channels shall be used. The final report shall discuss a preliminary manufacturing plan, design, safety, component specifications, performance characteristics and any recommendations for future enhancement of the cooling system. Phase II will include a preliminary commercialization plan at the midpoint.

PHASE III: Incorporating knowledge gained from users, studies and system integrations being performed on the Phase II prototype will be used for the final product design and preparation for production. Refine prototype and tooling for mass production and dual-use applications. During Phase III, this technology will be transitioned from a demonstrated field ready personal cooling system, to production products suitable for both military and commercial use wherever immediate, lightweight, portable cooling/dehumidification is needed. Phase III will include a detailed commercialization plan within the first month.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private Sector Commercial/Dual Use Applications: A modular cooling/dehumidification system for unventilated conditions would be highly desirable for certain occupations such as miners, petroleum industrial workers, firefighters, the nuclear industry, law enforcement, and emergency responders. Also, lightweight personal cooling system derivatives would appeal to strenuous recreational and athletic applications, such as hiking, cycling, and backpacking, as well as other outdoor activities in hot climates.

REFERENCES:
1. Azer, N. Z., McNall, P. E., & Leung, H. C. (1972). Effects of heat stress on performance. Ergonomics, 15(6), 681-691.

2. Kobrick, J. L., & Fine, B. J. (1983). Effects of heat and chemical protective clothing on cognitive performance. Aviation, Space, & Environmental Medicine, 58, 149-154.

KEYWORDS: MOPP; Heat; Humidity; Cooling; Dehydration; HAZMAT

N093-161 TITLE: Next Generation Helmet System

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

ACQUISITION PROGRAM: Program Manager for Infantry Combat Equipment (PM ICE), ACAT IV (T) program

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a Next Generation (N-Gen) helmet for the Marine Corps ground forces that provides improved protection against blunt force, ballistic, blast, blast pressure, fragmentation, flash heat, and battlefield noise. A N-Gen helmet will be designed as a scalable, modular system that offers attachment points for additional ballistic coverage of the mandible of the face and eye region of the head, noise reducing hearing protection, and common military devices such as night vision devices and flashlights.

DESCRIPTION: A N-Gen helmet will balance the Marine Corp’s need for a helmet design with improved survivability, modularity, and reduced weight over the current Light Weight Helmet (LWH). A N-Gen helmet will provide the ground forces with the ability to increase or decrease the area of and level of protection required based on the anticipated threat level for a mission. At a minimum, a N-Gen helmet should: provide better protection than the current LWH against blunt force, ballistic, blast, blast pressure, fragmentation, and flash heat; address critical human factor elements such as comfort, thermal management, weight, stability/center of gravity, and safety; provide seamless integration with and attachment points for additional ballistic protection (including but not limited to mandible face and eye region and nape), noise reducing hearing protection, current military devices such as night vision goggles and other common head mounted systems; be flame resistant and provide equal or greater durability that the LW helmet and be capable of operating in a wide range of military environments.

Additional features such as integrated voice communication, enhanced hearing for sound detection and localization, integrated visual displays, and other features of value are also desired.

USMC is open to new helmet design concepts and geometries to achieve the desired performance capabilities. Small businesses may design their own design/geometry or use the Army's Advanced Combat Helmet (ACH) geometry as an initial baseline design/geometry for the N-Gen helmet.

PHASE I: Identify and analyze common head mounted military equipment that must seamlessly integrate with a N-Gen helmet. Develop N-Gen helmet designs and concepts, including helmet shell and attachment points. Develop technical drawings for the proposed helmet geometry and attachment points, analyze and select final helmet shell material. Develop or identify potential N-Gen helmet suspension and retention systems. During this phase, the small business is encouraged to form any corporate partnerships that may be necessary to acquire all raw materials and sub-components and to manufacture N-Gen helmets during Phase 2.

At the conclusion of Phase 1, the selected small business shall provide the government with: final N-Gen drawings and draft specifications (for helmet sizes Extra-Small, Small, Medium, Large, & Extra-Large); identification of the selected ballistic material for the helmet shell; a list, with estimated weights, for all N-Gen helmet components; and a list of potential suspension and retention systems to be evaluated as part of the N-Gen helmet test and evaluation effort in Phase 2.

PHASE II: Construct initial prototype N-Gen helmets (minimum quantity of 25) for test and evaluation. Prototype helmets should include helmet shell, suspension and retention systems, attachment hardware, and any other components required. Test and evaluate the prototypes to establish baseline performance against blunt force, ballistic, blast, blast pressure, fragmentation, and flash heat. Based on test results, refine and optimize N-Gen design.

At the conclusion of Phase 2, the selected small business shall provide the government with: final N-Gen drawings; a product description and performance specification for the N-Gen helmet; test results from Phase 2 testing; and a minimum of ten N-Gen helmets for government test and evaluation.

PHASE III: Conduct system level integration testing with existing fielded military equipment and other commercial equipment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A N-Gen helmet may have broad applicability to various federal, police, fire, and emergency responder markets that seek modular helmet solutions that allow users the ability to customize the system based on their specific user preferences and mission sets.

REFERENCES:
1. Marine Corps Center for Lessons Learned. "Helmet Design and Testing". 31 May 2007.

2. Ivins et al. "How Satisfied Are Soldiers with Their Ballistic Helmets?" Military Medicine, Vol. 172, Jun 07, page 568.

KEYWORDS: Ballistic helmet; Light Weight helmet; Helmet

N093-162 TITLE: <u>DoD Engine Efficiency Enhancement Technology</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Space Platforms

ACQUISITION PROGRAM: Product Group 15, PEO Land Systems, ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop non-trivial retrofit engine technologies that can be adapted to existing vast base of DoD diesel and gas driven platforms to significantly increase (40% to 60% or greater) fuel efficiency. Does not require whole new engine, but rather upgrades/retrofits existing engine (reducing costs), maintaining parts availability of non-retrofit remainder of engine/transmission.

DESCRIPTION: Current large vehicle base across DoD typically very fuel inefficient. Current technology trends towards future systems involving any widespread usage of ultrahigh efficiency electric/fuel cell/hybrid system on large scales across DoD are probably still decades out, varying with budgets and technological availability and consequent manufacturing/cost capabilities.

Consider six stroke adaptations with (recycled water stroke steam being an additional power stroke along with the regular power stoke from diesel et.); consider additionally a ‘camless’ engine as well. Saving the engine block and much of the rest of the platform. Consider a ‘retrofit’ kit per vehicle motor type, that as vehicles were rapidly rebuilt, could be refurbished on current production schedules. Consider the use of advanced thermoelectronics to extract wasted heat energy in novel ways. This could act as an extremely efficient ‘bridge’ technology until Li- Ion, hydrogen fuel cells and/or other hybridic technologies come online.

PHASE I: Using a diesel engine type common across the DoD, select a platform for proof of concept to clearly, empirically, and physically demonstrate and document technologies that provide a 50-60% increase in fuel efficiency from unmodified base engine. Demonstrate repeatable benefits of each introduced level of technology. Demonstrate how efficiency is consistent under loading conditions.

PHASE II: Demonstrate capability across three different types of engines, including gas and diesel fuel types for significantly increased efficiency. Provide cost metrics to derive full cost to benefit ratios and effects on reliability, availability, and maintainability. As in Phase 1, clearly, empirically, and physically demonstrate 50-60% increase in fuel efficiency from the unmodified base engines. Clearly demonstrate and document benefits of each type of technology introduced onto each base engine. Demonstrate that introduced technologies do not deleteriously affect reliability, availability or maintainability.

PHASE III: Demonstrate manufacturability and cost reductions across all platforms. Provide retrofit kit systems that can be rapidly utilized in a rebuild/depot environment where the majority of the existing engine is retained. Provide cost benefits analysis.
Demonstrate that efficiency and cost effectiveness are not reduced for production variants of these technologies.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Significant potential not only for DoD, but across vast base of commercial hauling vehicles (numbering in the millions).

REFERENCES:
1. Six stroke engine technology explorations. INVENTION AWARDS 'Six Strokes of Genius'; http://www.popsci.com/node/9649
http://en.wikipedia.org/wiki/Crower_six_stroke

2. Camless engine technologies.
http://www.autoblog.com/2008/01/07/camless-engine-may-debut-on-2009-fiat-500-alfa-junior/2

3. Heat extraction, energy recovery systems (cutting edge energy extraction thermoelectrics)
http://www.sciencedaily.com/releases/2008/10/081009144327.htm
http://www.sciencedaily.com/releases/2008/07/080724150340.htm

KEYWORDS: ultrahigh engine energy efficiency six-stroke camless thermoelectrics

N093-163 TITLE: Innovative Heat Source Concepts for Field Food Service Equipment

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

ACQUISITION PROGRAM: PM Infantry Combat Equipment, Tray Ration Heating System, AAP

OBJECTIVE: Develop and demonstrate an alternative heat source for current and future field food service equipment.

DESCRIPTION: The current common heat source for Marine Corps food service equipment is the Babington Airtronic burner. This burner was fielded in 1996 as the heating source for the Tray Ration Heating System (TRHS), NSN 7310-01-295-7479. The same burner was later included as a retrofit in the M-59 field range, NSN 7360-00-082-2153.

As part of the current Marine Corps field feeding common burner concept, the same burner is being used in the development of the Expeditionary Field Kitchen (EFK). The current EFK prototypes use the Airtronic burner in multiple appliances to include the TRHS, a field sanitation unit (FSU), a tilt skillet, a combination oven, field ranges, and stock pots. A modern, alternate heat source is needed that can augment or replace the current burner system. A future heat source will need to be environmentally friendly, low in power consumption, and simple in design and maintenance.

PHASE I: The developer will expand on the proposed concept and demonstrate feasibility of using the concept as a replacement in current systems.

PHASE II: The contractor will develop a manufacturable prototype capable of performing in multiple field food service appliances in a wide range of environments.

PHASE III: Multiple branches of the US military have a need for a reliable, efficient heat source for their field food service equipment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Development of an energy efficient heat source could be used in multiple applications in the food service industry as well as in Humanaitarian Aid and Disaster Relief environments.

REFERENCES:
1. TM 09211A-14&P Operation and Maintenance Manual for the Tray Ration Heating System

KEYWORDS: Heat source, fuel, power, burner

N093-164 TITLE: Optical Aperture Gating for Single-pixel and Imaging LIDAR Systems

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA-264, Air Anti-Submarine Warfare Systems; ACAT IV

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop new innovative materials and a novel all-optical and fast gating technique that would improve daytime performance of photocathode type lidar detectors for aperture sizes approaching one square cm and larger.

DESCRIPTION: Innovative technology is sought that would provide photocathode protection for expensive, high-sensitivity detectors such as photomultipliers (PMTs) and intensified photodiodes (IPDs). Novel solutions should provide the capability of a superior gating technique for these detectors which are used in lidar systems and imaging systems. Current techniques are limited to electrical gating, such as dynode gating within PMTs, which mixes gate pulses with data signals causing signal distortion. Currently available electro- and acousto-optic techniques are not applicable as they require highly polarized and nearly collimated optical source to gate quickly and effectively.

Proposed solutions should take the following technical design goals into consideration. The proposed technique should require only minor design variations to work at specific wavelengths (e.g. at 480nm or 532nm) within the blue green spectrum (i.e. 450nm to 550nm). Strong out-of-band blocking should be included. The gate-off to gate-on contrast should approach -30dB. The loss for the gate-on condition should be minimal (e.g. < 2dB). The technique should work with unpolarized light with ensemble incident angles from collimated to at least +/- 10 degrees (+/-40 degrees desirable). Single-pixel lidars need gate-off to gate-on transition times of 100 nanoseconds or faster, while gate-on to gate-off transition times of a few hundred nanoseconds are reasonable. Gate-on state duration times of one to a few microseconds is useful. Imaging lidar applications need off–on and on-off transition times of 10 nanoseconds or faster with a gate-on duration of 10s of nanoseconds. The gate repetition frequency should be at least 1 KHz and be capable of synchronizing, with very low jitter, to an external trigger.

Techniques such as, but not limited to, holography and dynamic-holography, exploiting electro-optic refractive effects and photo-refractive effects are appropriate. Conceivably the solution would be in the form of one or a few optics that could be integrated into the middle or back end of a standard telescope design (e.g. refractive, reflective). Control signals (e.g. trigger timing) and power would be externally applied. The technique would perform optical gating of the light input to a detector at the back end of a telescope. The baseline design should operate with a gated aperture size approaching 1 square centimeter or larger.

PHASE I: Demonstrate feasibility of proposed approach. Generate ray-trace design diagrams showing component locations within a simple telescope design. Demonstrate proof-of-concept with consideration to scaling to larger aperture sizes, cost and availability of required materials and services. Perform preliminary bench-top testing to verify performance of potential designs.

PHASE II: Develop and demonstrate a working bench-top design at 532nm and develop and deliver a fully functioning prototype with a 1 square cm aperture. Generate a complete design for operation at 480nm. It is anticipated that small companies will seek a commercialization partner capable of manufacturing larger aperture versions.

PHASE III: Complete prototype development and document the design. Transition the technology to air and underwater remote sensing applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications that would benefit from an all optical gating technique include all optical sensor systems such as single-pixel and imaging LIDAR Systems for DOD and civilian uses for land-based, airborne and satellite applications. Benefiting applications include air and underwater remote sensing and airborne mapping.

REFERENCES:
1. Photomultiplier Tubes - Principles and Applications, Philips Photonics, sect. 3.1.5 Exposure, p3-6, 1994.

2. Photomultiplier Tubes - Basics and Applications 3rd Edition, Hamamatsu Corp., Chapter 10 MCP-PMTs, Sect 10.2.4 Saturation Effects, P211, 2006.

KEYWORDS: Lidar; Electro-refractive; Photo-refractive; Dynamic-holography; Photomultiplier; Photocathode

N093-165 TITLE: Optimal Autorotative Profiles Using Active Inceptor Cueing

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-261 H-53 Heavy Lift Helicopter Program, ACAT I; PMA-276 H-1

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop innovative methods for improving handling qualities and/or safety by reducing flight path variability in autorotative descent and landing using the additional cues provided by active controller inceptors.

DESCRIPTION: If a rotorcraft loses engine power, the pilot must enter an autorotation. A rotor is in an autorotative state when it is being driven only by the upwards airstream. This condition is reached in relatively high rates of descent that are proportional to the square-root of a rotorcraft's disk loading, which is defined as the weight of the rotorcraft divided by the area of the main rotor. The amount of kinetic energy that can be stored within the rotor system and the rate it is dissipated in a flare are important factors that must be considered. A common measure of these characteristics is called the "autorotative index," which is the ratio of the kinetic energy stored in the main rotor system to the rotorcraft's gross weight. Disk loading and autorotative index may be extremely difficult to optimize for autorotative performance due to conflicting requirements, such as mission requirements driving overall weight, shipboard compatibility driving main rotor size, and structural constraints driving rotor inertial characteristics.

Modern rotorcraft designs have tended toward high disk loading and lower autorotative indices increasing the difficulty of performing a safe, repeatable autorotation to landing. Training, in a simulator or in-flight, provides the pilot with much needed practice for this high workload, dynamic, difficult maneuver. The pilot has to master the various phases of the autorotation. The autorotation entry is important since too long a delay can decay rotor speed. During the descent, the pilot will have to turn toward a suitable landing area while maintaining rotor speed within limits. The final phase is critical, requiring a cyclic flare to bleed off airspeed and increase rotorspeed coupled with a timed collective pull to slow the descent rate before touchdown. However training alone has not been able to completely remove flight control misapplication and/or improve the handling qualities in an autorotation to a sufficient level needed to guarantee a safe landing where physically possible. This means Height-Velocity avoid regions are drawn larger than what physics alone dictates. As rotor inertias decrease in future rotorcraft designs, the pilot will have to perform this maneuver with less reaction time and in a more precise manner in order to survive engine failure or tail rotor loss.

Previous research work, such as that done by STI on autorotation training displays, has been done to increase the visual cues in the cockpit provided to the pilot in an autorotative descent. These cues ensure the rotorcraft has the maximum amount of stored kinetic energy available just prior to the flare and landing. While helpful, these artificial display cues require the pilot to continuously look inside the cockpit to ensure the autorotation profile is adhered to. A method to provide guidance to the pilot, while keeping the pilot scan external to the cockpit, is needed. Tactile cues via the control inceptors are immediate, unambiguous, and require no interpretation as to what control response is required to remedy the situation. Active control inceptors (pilot cyclic, collective and pedals) have been recognized as being more effective and accepted than other systems such as the Tactile Situational Awareness System (TSAS.) The upcoming CH-53K program specifies active control inceptors due to the potential tactile cueing that would allow "Carefree Maneuvering." Carefree Maneuvering is the concept that the aircraft won"t allow the pilot to exceed limits by using advanced control laws and tactile cues, thus reducing workload resulting in increased safety and mission effectiveness. The employment of tactile inceptors toward this is not fully understood and much research needs to be done.

There has also been research in the area of tactile cueing systems, via the pilot's active control inceptors. While the focus of this research has been to reduce pilot workload in maneuvering flight by making the monitoring of certain structural, engine and flight limits more intuitive, the benefits of a tactile cueing system in autorotative flight have never been explored. Preliminary research recently done by ONERA and DLR presented the use of tactile cueing to prevent pilots from reaching high sink rates and Vortex Ring State (VRS). The VRS research was done to give the pilot cueing to stay within a certain envelope, whereas this autorotation research would provide pilotage commands in order to make a safe autorotative landing. This preliminary research into using tactile cues for VRS avoidance is a good start, but the autorotation problem is much more complex and dynamic.

The advent of the active stick/cyclic and active throttle/collective coupled with digital flight control laws provides an opportunity to provide very specific tactile cueing to the pilot through the cyclic and collective on optimum speed and descent rate to maintain the correct balance of kinetic energy and potential energy throughout the autorotation profile. Bidders should explore possible mechanizations and programming of cyclic and collective gradients, soft or hard stops to assist the pilot more effectively in managing energy during the autorotation profile. Existing research on methods for determining optimum autorotation profiles based on available aircraft state information should be utilized to the maximum extent possible.

PHASE I: Determine via simulation and/or analysis the optimal tactical cue(s), via the control inceptors, that can be provided to the pilot during an autorotative descent through to a landing that will increase the probability of a safe landing. Examine various control inceptor configurations to ensure proposed cue(s) are beneficial regardless of cockpit layout. Evaluate the feasibility of such an approach. Develop a conceptual design for a heavy lift helicopter (H-53K) configuration.

PHASE II: Demonstrate the proposed cues through a piloted rotorcraft simulation evaluation where various autorotative descent and landing profiles must be followed. Demonstrate that these cues, via piloted simulation, effectively improve handling qualities and reduces the possibility of misapplication of pilot controls in an autorotative descent, to include the landing. Demonstrate that the cueing solution is robust to misapplication of controls and is flexible to environmental or mission changes post engine(s) failure.

PHASE III: Develop a production ready solution. Perform verification and validation of the developed technology and demonstrate that the cueing system can be easily installed in a wide range of rotorcraft, regardless of inceptor configuration and rotor/airframe characteristics.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The solution developed here can be applied to helicopter platforms. Incorporation in other platforms can result in a potential reduction in development and operation costs.

REFERENCES:
1. Leishman, J. G., Principles of Helicopter Aerodynamics, Cambridge University Press, New York, 2006.

2. Bachelder, E., Lee D., Aponso, B., Pollack, M., Germanowski, P., “Improved Method for Evaluating OEI Height Velocity Boundaries,” presented at the American Helicopter Society Forum, 2006

3. Sahasrabudhe, V. et al., “Simulation Investigation of a Comprehensive Collective-Axis Tactile Cueing System,” presented at the American Helicopter Society 58th Annual Forum, Montreal, Canada, 11-13 June 2002.

4. Abildgaard, M., Binet, L., von Grünhagen, W., Taghizad, A., “VRS Avoidance as Active Function on Side-Sticks,” presented at the American Helicopter Society 65th Annual Forum, Grapevine, Texas 27-29 May 2009.

5. Aponso, B., Lee, D., Bachelder, E., “Evaluation of a Rotorcraft Autorotation Training Display on a Commercial Flight Training Device,” Presented at AHS Forum 61Grapevine, Texas 3 June 2005.

6. Howitt, Jeremy, “Carefree Maneuvering In Helicopter Flight Control”, American Helicopter Society 51 st Annual Forum, Fort Worth, TX, USA, May 9-11, 1995.

7. Whalley, M. S., “A Piloted Simulation Investigation of Helicopter Limit Cueing”, USAATCOM TR 94-A-020, NASA TM-108851, October 1994.

8. Einthoven, P. E., Miller, D. G., and Thiers, G., “Tactile Cueing Experiments with a 3-Axis Active Sidestick Controller”, American Helicopter Society 57 th Annual Forum, Washington, D.C., USA, May 8-11, 2001.

KEYWORDS: Autorotation; Active; Inceptor; Cueing; Tactile; Safe

N093-166 TITLE: Adjusted Nitrogen Alloyed Stainless Steel with Optimized Thermal Processing for Superior Balanced Performance

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I

OBJECTIVE: Develop highly corrosion resistant bearing and gear steels with surface technology for robust wear, scuffing, and rolling contact fatigue resistance.

DESCRIPTION: Corrosion protection of high performance bearing and gear steels without debit of mechanical and tribological properties is critical for sustaining Navy equipment readiness. Due to insufficient corrosion resistance of bill-of-material bearings and gears, the U.S. Navy has developed corrosion inhibited oils for aircraft propulsion systems. These specially formulated oils are utilized to reduce the number of rejected mechanical system parts at overhaul due to corrosion. Oil formulations for corrosion protection limit the ability of these oils for boundary lubrication (tribology) performance. The lubrication performance penalty limits the growth in power density needed for aero propulsion engine and gearbox systems. Advanced bearing steels, like carburized case hardened Pyrowear 675, provide reasonable tribology performance, but only marginal improvement in corrosion protection. A new family of stainless steels: High Nitrogen Martensitic Stainless Steels (HNS) have recently been developed with excellent corrosion resistance. In addition to corrosion resistance, these steels have excellent rolling contact fatigue resistance. However, they lack essential attributes for abrasive and adhesive wear resistance. HNS bearing surfaces also have poor resistance to high speed and high temperature scuffing. This is due to the very alloy formulation that provides corrosion resistance but has not been optimized for balanced mechanical and tribological properties. Rather, current HNS attributes for corrosion resistance appear to be at odds with boundary lubrication. The surface must have sufficient iron or iron oxide content to react with oil additives. Chrome oxides (for corrosion protection) limit the surface reactivity for the formation of boundary lubricating films. In addition, the micro-structure of HNS seems to have limited shear stability to avoid adhesive wear or catastrophic scuffing.

PHASE I: Demonstrate the feasibility of bearing or gear steels with both high corrosion resistance and robust tribology performance.

PHASE II: Develop, test and demonstrate prototype bearing or gear steels. Perform corrosion resistant testing and key tribology performance attribute testing for wear, scuffing and rolling contact fatigue (both surface and subsurface initiated). Cooperation with a bearing company and OEM engine company should be considered. A viable series of test methods should be established to provide production ready technical information. The test methods may include attributes for wear, scuffing and fatigue, as well as their competitive interactions.

PHASE III: Finalize the designed technology and establish commercialization of the material and surface modification technologies. Transition the technology to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Direct spin-off of corrosion resistant steels with robust tribology performance is immediately possible in marine equipment, heavy duty construction equipment, automotive and industrial applications where corrosion is important. Efficient and cost-effective production methods are essential for dual use applications.

REFERENCES:
1. H. Spikes. “Tribology Research In The Twenty-First Century.” Tribology International, Volume 34, Issue 12, December 2001, Pages 789-799

2. H. Berns, F-J Ebert and H-W Zoch. “The New Low Nitrogen Steel LNS – A Material for Advanced Aircraft Engine and Aerospace Bearing Applications.” Bearing Steels: Into the 21st Century, ASTM STP 1327, J.J. Hoo and W.B. Green Eds, American Society for Testing and Materials, 1998.

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Microstructures and Mechanical Properties, J. Phys, IV France 11 (2001) Pr4-303-Pr4-309; http://cat.inist.fr/?aModele=afficheN&cpsidt=1121925

4. D. Girodin, L. Manes, J-Y. Moraux and J-M. de Monicoult. "Characterization of the XD15N High Nitrogen Martensitic Stainless Steel for Aerospace Bearing." 4th International Conference on Launcher Technology "Space launcher Liquid Propulsion", 3-6 Dec. 2002, Liege (Belgium); http://www.snr-bearings.com/group/fr/fr-fr/file.cfm/04characterisationofxd15n.pdf?contentID=1155

KEYWORDS: Corrosion resistant steels; Bearings; Gears; Surface treatments; Tribology; Heat treatment

N093-167 TITLE: Automated Marine Mammal Mitigation Sensor for Multi-Static Active ASW

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: PMA 264 Advanced Extended Echo Ranging (AEER) ACAT IV

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Design and develop automated, low power active sonar or other technology for detection, location and inbound or outbound tracking of proximate marine mammals.

DESCRIPTION: Multi-static active (MSA) sonar systems are entering the pipeline as key components in the Navy's anti-submarine warfare (ASW) toolkit. Use of these systems in increasing numbers will impact marine mammals. Innovative solutions are sought to develop an acoustic (or nonacoustic) sensor capable of detecting, and tracking marine mammals within a specified target test range of approximately 300 meters. The final version of the sensor needs to fit within the size, weight, power and processing constraints of the AN/SSQ-125 source buoy. For acoustic sensors, using or modifying the main transducer is an acceptable approach, as is adding a small self-contained hydrophone/transducer. In addition the acoustic source power level should be no greater than 190 dB, with a goal of not exceeding 173 dB.

Currently, passive marine mammal mitigation techniques are used that rely on visual whole field monitoring or vocalization detection at the receiver sonobuoy. This approach is very manpower intensive. An automated processing technique that reduces operator workload and that is contained in the source buoy is therefore desired. The technique should be able to search the environment in three dimensions at the estimated range of about 300 meters, and alert the operator if detection occurs.

Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been be implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material In Accordance With DoD 5220.22-M during the advance phases of this contract.

PHASE I: Determine the feasibility of developing automated low power active sonar or other technology to detect and track marine mammals within a specified range of approximately 300meters. Provide analysis to show that technique will provide a high probability of detecting and tracking marine mammals in various sea states or other ocean effects and show that source power levels will not exceed 190 dB.

PHASE II: Based upon Phase I results develop prototype of sensor and demonstrate using modeling and simulation. If funding permits, test sensor in over the side lake tests.

PHASE III: Develop sensor and integrate with the AN/SSQ 125. Conduct over the side ocean environment tests. Transition technology to the fleet and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Marine mammal avoidance techniques could translate directly to commercial fishing and oil exploration industries as well as scientific processes for marine mammal studies.

REFERENCES:
1. Urick, Robert J. "Principles of Underwater Sound." Peninsula Publishing, California, 1983, 423 pages.

2. Richardson, W.J., Greene Jr., C.R., Malme, C.I., Thomson, D.H. "Marine Mammals and Noise." Academic Press, San Diego, California, 1995, 453 pages.

KEYWORDS: Anti-submarine warfare; Multi-static active; Automated recognition and controls; Marine mammal mitigation; Sonobuoy; Advanced Extended Echo Ranging

N093-168 TITLE: Target Localization Using Multi-Static Sonar with Drifting Sonobuoys

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: Advanced Extended Echo Ranging ACAT IV-T and Improved Extended Echo Ranging

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop an algorithm capable of accurately locating a target using only acoustic signals collected on a passive and active multi-static sonar system consisting of drifting buoys without the use of other data to locate the buoys.

DESCRIPTION: Algorithms are currently used to locate targets in the ocean using active and passive multistatic sonobuoy systems. These systems currently require a means to accurately locate drifting buoys in order to accurately locate the targets. A need exists to accurately locate targets from acoustic data alone without using other navigational data such as aircraft sightings, radar, or global positioning systems (GPS). Using acoustic signals by themselves to accurately locate targets and produce reliable confidence limits for target locations would increase the reliability and simplicity of the system while reducing cost. Past approaches, such as those concentrated on using a particle filter or Kalman filter algorithm (see references), have been unsuccessful. The algorithm for locating targets should take into consideration all relevant sources of error and produce accurate confidence limits that contain the correct target location. The algorithm should be able to overcome any uncertainties in buoy locations yet still converge to the correct answer for the target and its confidence limits.

PHASE I: Develop and define an algorithm that yields accurate locations and accurate confidence limits on location for targets using only acoustic data from drifting active and passive sonobuoys in the ocean.

PHASE II: Apply the algorithm to several sets of field data collected during actual sea tests. Demonstrate the algorithm with simulated data using realistic scenarios.

PHASE III: Integrate the algorithm into aircraft (e.g. P-3, H-60, or surrogate). Transition the system into aircraft used for surveillance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Developed technology would potentially benefit existing systems where locations of transmitters or receivers are not accurately known.

REFERENCES:
1. “Sequential Monte Carlo Methods in Practice:” Doucet, Freitas, and Gordon (editors), ISBN 0-387-95146-6

2. “Applied Optimal Estimation:” Arthur Gelb (editor), ISBN 0-262-57048-3

3. Stan E. Dosso and Nicole E. B. Collison, “Acoustic tracking of a freely drifting sonobuoy field,” J. Acoust. Soc. Am. 111 (5), May 2002, page 2166. [There are also several pertinent references contained therein.]

4. John L. Spiesberger, “Geometry of locating sounds from differences in travel time: Isodiachrons”, J. Acoust. Soc. Am. 116 (5), Nov 2004, page 3168.

5. John L. Spiesberger, “Probability distributions for locations of calling animals, receivers, sound speeds, winds, and data from travel time differences,” J. Acoust. Soc. Am 118 (3), Sept 2005, page 1790.

6. John L. Spiesberger, “Hyperbolic location errors due to insufficient numbers of receivers,” J. Acoust. Soc. Am. 109 (6), June 2001, page 3076.

7. Nathan Marchand, “Error Distributions of Best Estimate of Position from Multiple Time Difference Hyperbolic Networks,” IEEE Transactions on Aerospace and Navigational Electronics, June 2009, page 96.

8. Ralph O. Schmidt, “A New Approach to Geometry of Range Difference Location,” IEEE Transactions on Aerospace and Electronic Systems, Vol. 8, No. 6, Nov 1972, page 821.

KEYWORDS: Sonobuoy; Position; Confidence Limits, Sequential Estimation; Target Location; Algorithm

N093-169 TITLE: <u>Composite Airframe Damage Detection and Evaluation</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA-261, H-53 Heavy Lift Helicopters Program

OBJECTIVE: Develop and demonstrate a Nondestructive Evaluation/Structural Health Monitoring (NDE/SHM) technique to detect structural damage and monitor the airframe and it's components for small incipient damage in inaccessible areas.

DESCRIPTION: NDE of aircraft components typically requires disassembly and slow techniques such as ultrasonic and mechanical impedance inspection methods. A NDE technique is needed that can detect incipient damage in complex geometry components which are assembled, i.e. helicopter main rotor hubs and blades as well as fuselage components. Existing NDE techniques typically consist of a tiny sensor which is only detecting flaws that the sensor passes over as an inspector manually scans the surface or an automated scanner moves the sensor. However when all critical components are assembled to make up an airframe some the load critical components are no longer accessible to perform NDE. What is needed is a method of monitoring the entire structure from just a few sensors which could have the same sensitivity as a scanning NDE system. This technique should perform as a SHM system. The proposed NDE/SHM concept must be able to inspect inaccessible areas rapidly with only a few sensors attached to the component. For in-flight structural health monitoring the entire system must not weight more than one pound.

PHASE I: Develop an approach that demonstrates the ability to detect small incipient damage of aircraft representative parts in inaccessible areas.

PHASE II: Applying the Phase I results, develop and manufacture a prototype system for application on small inaccessible areas for inspections. Demonstrate and validate the effectiveness of the inspection process through testing of representative test specimens and actual CH-53K specific components.

PHASE III: Transition the approach to CH-53K and additional platforms with similar needs of inaccessible area inspection.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology is also applicable to composite airliners and wind turbines that require inaccessible area inspection.

REFERENCES:
1. O. Buck, W.L. Morris, J.N. Richardson. "Acoustic harmonic generation at unbonded interfaces and fatigue cracks". Appl Phys Lett, 33(5), 1978, pp. 371-373.

2. V.A. Antonets, D.M. Donskoy, A.M. Sutin. "Nonlinear vibro-diagnostics of flaws in multilayered structures". Mech Compos Mater, 15, 1986, pp. 934-937.

KEYWORDS: composite; nondestructive evaluation; structural health monitoring; critical components; inaccessible components; incipient damage

N093-170 TITLE: Spline Health Prognosis via Physics Based Modeling Coupled with Component Level Tests

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-299, H-60 Helicopter Program

OBJECTIVE: Develop physics based spline health prognosis models for fretting fatigue and crack propagation failure modes.

DESCRIPTION: The algorithms that are currently employed for determining spline health are rudimentary and are primarily empirically derived from health monitoring sensor data obtained from system or subsystem component tests. These algorithms mainly rely on rotational speed and tooth meshing frequencies, or are statistical in nature. The physics based models of spline faults developed under this topic should include fretting fatigue failure modes as well as crack propagation into the bulk stress area of the component. The physics based models should account for specific characteristics of the splines being modeled including geometry, alloy composition and materials characteristics, residual stress, case and core hardnesses, case depth, ratio of case thickness to tooth thickness, surface finish and machining characteristics. These models must be able to be updated via sensor feedback from operating spline tests. Test to failure of the modeled splines is required in order to refine the models, to demonstrate the ability to calibrate the models via sensor feedback, and to validate the ability of the models to accurately quantify the current health state and predict remaining useful life.

PHASE I: Design and develop physics based spline health models to quantify fretting fatigue as well as crack initiation and propagation failure modes. Develop and demonstrate proof of concept models and associated state awareness sensors that are capable of making the required health assessments of spline health.

PHASE II: Refine the models for accuracy by accounting for geometry, alloy composition and materials characteristics, residual stress, case and core hardnesses, case depth, ratio of case thickness to tooth thickness, surface finish and machining characteristics. Conduct demonstration tests to characterize the capability of the models to accurately quantify the current state and to predict the remaining useful life of the modeled components. Refine the models as necessary and validate via test.

PHASE III: Conduct necessary qualification testing and finalize the physics based spline health prognosis models for transition to both military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The physics based spline health prognosis models developed under this topic would significantly enhance the state of the art for commercial aviation. The technology is directly transferable to military and commercial gearbox applications.

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2. Advanced Vibration Analysis to Support Prognosis of Rotating Machinery Components. http://www.impact-tek.com/Resources/TechnicalPublicationPDFs/Aerospace/Impact_ADT_AdvancedVibrationAnalysisPrognosisRotatingMachineryComponents_VIBINST05.pdf

KEYWORDS: Spline; Prognostics; Models; Pitting; Spalling; Fatigue

N093-171 TITLE: Innovative Approaches for Enhancing Interlaminar Shear Strength of Two-Dimensional (2D) Composite Reinforced Flexbeams and Yokes

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-261, CH-53K Heavy Lift Helicopter Program

OBJECTIVE: Develop effective low-cost methods for improving interlaminar shear strength of two-dimensional 2D flexbeams and yokes for rotor systems.

DESCRIPTION: The CH-53K heavy lift and other rotary wing military platforms are targeting composites for rotor hub applications with an ultimate goal of weight reduction. However, concerns exist over acquisition cost, reliability, durability and life expectancy. Current rotor hub components are typically fabricated with 2D woven carbon and fiberglass fabric reinforcement. 2D components have been found to be life-limited in high cycle and fatigue environments due to inherently low matrix dominated interlaminar shear strengths. Three-dimensional (3D) fiber architectures offer the potential for increased durability by enhancing the interlaminar and through-thickness mechanical properties; however, their implementation may be cost and weight prohibitive. Attempts at 3D braiding and weaving have resulted in reduced inplane properties and expensive preforms requiring expensive tooling for Resin Transfer Molding (RTM) processes. Innovative solutions are sought for flexbeams and yokes that may include design, process, material, or tooling that would increase the interlaminar shear strength without degrading inplane properties.

PHASE I: Develop an efficient low-cost method or solution for improving the interlaminar shear strength of 2D rotor hub laminates. Demonstrate the feasibility of the developed approach by showing a strength improvement over a baseline material through the fabrication and testing of a limited number of coupon specimens.

PHASE II: Provide practical implementation of a production-scaleable process to implement the method or solution developed under Phase I. Validate the approach through the fabrication and testing of a sufficient quantity of material property test coupons. Develop a prototype of the design for a rotor hub component using the method or solution for improving the interlaminar shear strength.

PHASE III: Transition the approach to CH-53K and additional rotor hub applications both military and commercial.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advanced composite rotor hub components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy. The resulting fabrication approach can transition to the energy generation industries for such applications as wind turbines and propeller hubs.

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4. "Methods of Interlaminar Reinforced Refractory Matrix Composites" Posted on MR&D, http://www.m-r-d.com/expertise/composite-materials.htm

5. ASTM D2344, Standard Test Method for Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short-Beam Method.

KEYWORDS: Polymer Matrix Composite; Two-Dimensional Reinforcement; Rotor Hub Systems, Interlaminar; CH-53K; Cost Reduction; Weight Reduction

N093-172 TITLE: Compact Energy Harvesting Power Supporting an "A" size Sensor

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

ACQUISITION PROGRAM: PMA-264 Air ASW Systems

OBJECTIVE: Develop innovative concepts for harvesting energy within a small (< 4.0 inch diameter) cylinder compatible with deployment of "A" size AN/SSQ-101 Advance Deployable Active Receiver (ADAR) sensor.

DESCRIPTION: Aircraft deployed sonobuoys provide continuous acoustic information for up to eight hours. At the end of that six hours, the Navy then needs to re-seed the sonobuoy pattern as the battery power diminishes. The Navy's ability to harvest energy by converting sea energy to electrical power confined to the existing volume in an "A" size sensor greatly enhances the passive sensors life employed in Anti-Submarine Warfare. The extracted (harvest) sea energy can be then stored using a rechargeable battery reduces the number of batteries placed into each sonobuoy. The three ways that appear inviting for buoy power are kinetic energy in the form of vibrations, radiation as solar energy, and thermal energy. Select and develop a methodology that is optimal for deployable buoy source implementation.

The cylinder must provide the ability to replenish the power source (battery cells) of the deployed unit and be robust to support deployment and operational environment. The energy harvesting power system should occupy the same or less volume of space then the current power supply and found in the current "A" size ADAR sonobuoy. The application design should produce enough energy generated by kinetic energy (e.g. sea state 2 to sea state 4) to continuously produce 0.2 -1.4 AMPS of rechargeable energy power energy for storage. The deployed ADAR sonobuoy should be able to function for not less than 8 hours continuous life. (Should have A minimum of 18 volts, supporting a minimum of 1.1 amps, 8.2 AMPS continuous per hour, sea battery is silver chloride), 4.875 inches, diameter, battery size is 3.25 inches in thickness.

PHASE I: Design and develop an innovative concept for converting ocean energy for buoy battery power replenishment within an "A" size ADAR sonobuoy. Demonstrate in theory the effectiveness of the candidate technology through mechanical and electrical modeling.

PHASE II: Fabricate a prototype system and test using an existing operational Fleet "A" sonobuoy, AN/SSQ-101 ADAR at variable depths of 65', 175' and 300' with simulated sea states as to assess power extraction and conversion levels. With mechanical and electrical models demonstrate the ability to provide scalable amounts of power extraction over varying sea-state conditions.

PHASE III: Examine ruggedizing the design for shock and vibration requirements for deployment. The ADAR Prototype should be mature for transition to the Fleet as an appropriate Navy "A" size sensor capable of being powered by the ocean once deployed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting efficient power unit could offer a wide ranging ability to provide emergency power to marine systems supporting marine mammal mitigation, beacon markers, portable electronics and emergency equipment. Capability also could provide an alternative means to harvest energy for coastal states. This energy means could also be implemented for buoy systems for the Coast Guard, Homeland Security and NOAA.

REFERENCES:
1. O'Donnell, Terence and Wang, Wensi. "Power Management, Energy Conversion and Energy Scavenging for Smart Systems." Ambient Intelligence with Microsystems, Springer US ISSN 1389-2134 (2008)

2. Woo Kim H., Uchino, K. and Daue, T. "Energy Harvesting With Flexible Piezocomposites." ACTUATOR 2006, 10th International Conference on New Actuators, 14 – 16 (2006)

3. Savelli, Guillaume, Plissonnier, Marc, Bablet, Jacqueline, Salvi, C, and Fournier, J. "Energy Conversion Using New Thermoelectric Generator." Proceedings DTIP (April, 2006)

4. Helms C. E., John, M. and Wyld, L. D. "Meeting the Submarine Challenge: A Short History of the Naval Underwater Systems Center." U.S. Gov't. Print. Office (1997)

5. Davis, Philip. "Underwater Power Generation Using Underwater Thermocline." US Patent No. 7,262,360 (2007)

6. Photo of "ADAR Deployed" supplied by TPOC 8/28/09 in JPG format.

KEYWORDS: Energy Harvesting; Wet Sensor; Electronics; Power Efficiency; Power Source; Kinetic Energy

N093-173 TITLE: Dielectric Resonator Antenna

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA290, Maritime Patrol and Reconnaissance Aircraft Program

OBJECTIVE: Design and develop a multimode dielectric resonator antenna (DRA) or antennas capable of operating in the frequency band of 30 MHz to 2 GHz that can cover some or all of the current VHF/UHF line-of-sight (LOS) communications, UHF satellite communications, L-band and GPS functions requirements that can be used on a Navy aircraft. Proposed concepts should demonstrate improvement in either size or RF performance over the current antennas.

DESCRIPTION: Currently, naval aircraft are covered with many antennas for VHF/UHF LOS communications, UHF satellite communications, L-band and GPS functions. Some of these antennas are of the blade type whose bandwidths are difficult to extend and whose form can impact the flight characteristics of the aircraft and create an ice accumulation hazard. Other, low profile, designs are usually cavity-backed requiring significant protrusion into the slipstream outside the aircraft or significant hull penetration inside the aircraft to accommodate the cavity whose bandwidths are also difficult to extend. There is a need to investigate alternate antenna technologies to ultimately condense some of these functions into a single structure to free up space for future additions, alleviate some of the interference between the antennas as well as reduce the size of existing antennas. Innovative concepts are sought that will demonstrate gain, pattern shape, polarization, power handling capabilities and VSWR potentially achievable by DRAs. Demonstration of all of these characteristics is not required although a successful proposal will incorporate as many as possible.

As a guide, the antenna requirements of the current antenna technology is given below:

VHF/UHF LOS communications:
Vertical polarization, omni-directional, transmit and receive, 30 Watts CW power handling, 50 Ohms impedance
30-88 MHz, -15 dBil (30 MHz), -5 dBil (88 MHz), 2.5:1 VSWR
118-174 MHz, -5 dBil average, 2.0:1 VSWR
225-512 MHz, 0 dBil average, 2.0:1 VSWR

UHF satellite communications:
Right Hand Circular polarization, hemi-spherical coverage, transmit and receive, 200 Watts CW power handling, 50 Ohms impedance
225-400 MHz, 5 dBic, 2.0:1 VSWR

L-Band:
Vertical polarization, omni-directional, transmit and receive, 50 Watts CW 4 kWatts peak power handling, 50 Ohms impedance
960-1220 MHz, 0 dBil average, 1.4:1 VSWR
1000-1100 MHz, 1.4:1 VSWR

GPS:
Right hand circular polarization, hemi-spherical coverage, receive only, 1.5:1 VSWR, 50 Ohms impedance
L1 (1563-1588 MHz), 4 dBic peak gain, > -3.0 dBic @ 80° off boresight
L2 (1215-1240 MHz), 4 dBic peak gain, > -3.0 dBic @ 80° off boresight

The design can be above the mold line or below. Primary constraints are weight and surface area consumed as weight allowance and surface area are always at a premium on any aircraft. It can be assumed that isolation will be handled by separate circuitry but each function should have a separate RF connector.

PHASE I: Demonstrate feasibility of proposed DRA concept using either computer modeling and/or laboratory test with limited measured data.

PHASE II: Develop, fabricate and demonstrate prototype (lab model) DRA to design goals.

PHASE III: Transition developed antenna technology to fleet via airborne integration, operation, evaluation and production assuming sponsorship is secured from NAVAIR aircraft program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed under this effort will have potential applications to unmanned air/surface/sea vehicles, multi-mission aircraft or any military aircraft or commercial aircraft where multiple antennas are used and space is limited.

REFERENCES:
1. J. L. Volakis (ed.), Antenna Engineering Handbook, 4th Ed., Chap. 17, A. A. Kishk and Y. M. M. Antar, "Dielectric Resonator Antennas", (New York: McGraw-Hill. 2007).

2. Y. Kobayashi and T. Tanaka, IEEE Trans Microwave Theory Tech., vol. MTT-28 (1980): 1077.

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5. A. Petosa, Dielectric Resonator Antenna Handbook, (Artech House, 2007).

KEYWORDS: Antenna; Wide-band antenna; Dielectric resonator; Communications; Navigation; Satellite

N093-174 TITLE: Nondestructive Detection of Fiber Waviness in Laminates

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

ACQUISITION PROGRAM: Joint Strike Fighter (ACAT I); H-53 Heavy Lift Helicopter Program

OBJECTIVE: Develop a nondestructive inspection technique capable of detecting and characterizing fiber waviness/marcelling in graphite/epoxy and fiberglass/epoxy laminate materials.

DESCRIPTION: Fiber waviness in laminate materials can result from various aspects of the manufacturing process. Since fiber waviness or marcelling reduces structural strength, its detection and characterization is of importance to the Navy. Having a means of detecting and quantifying fiber waviness would significantly improve the quality control process of thick laminate parts subject to defects of this kind. While traditional ultrasonic and radiographic techniques have been used in the past, they are not reliable for more complex geometries. For this reason, an affordable nondestructive tool is desired to reliably detect, measure, and characterize fiber waviness in laminate materials. The primary materials of focus are graphite/epoxy and fiberglass/epoxy laminates of various geometries and up to 0.75 inch thick. Detection of fiber waviness throughout the thickness of the part is required. Consideration also needs to be given to other materials or obstructions that may exist between layers in a part. Composite fiber waviness must be detectable in and around molded-in metal sections of the component under inspection.

PHASE I: Develop and demonstrate an innovative technology that detects and measures in-plane and out-of-plane fiber waviness in graphite/epoxy and fiberglass/epoxy laminate materials. Manufacture or procure necessary laminate samples for feasibility demonstration.

PHASE II: Develop, construct and demonstrate a prototype for characterization testing and evaluation, capable of detecting and quantifying fiber waviness. Demonstrations should be performed using samples that are manufactured or procured and that are representative of what can be expected in the Fleet.

PHASE III: Implement full-scale production of the nondestructive evaluation (NDE) devices in quantities proportional to market and Navy demand.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Quality control process improvements from this technology would be applicable to any industry that is using composite material construction; i.e.; automotive, wind turbines, ship building, and commercial aircraft. Additionally, this technology may be developed into a low-cost replacement for medical computer tomography.

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3. D. Cerniglia, K. Y. Jhang, and B. B. Djordjevic “Non-Contact Ultrasonic Testing of Aircraft Lap Joints,” 15th World Conference on NDT, Rome, Italy, Editor AIPnD, NDT.net October 2000.

KEYWORDS: Fiber Waviness; Fiber Distortion; Fiber Wash; Marcelling; Nondestructive Inspection; Nondestructive Testing

N093-175 TITLE: Innovative Materials for Highly Loaded Wear Application in Arresting Gear Tailhook Components

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I

OBJECTIVE: Develop and demonstrate innovative materials for wear intensive, highly loaded arresting gear tailhook components.

DESCRIPTION: Unique tailhook materials are required to meet the dynamic performance needs of aircraft arrestment during carrier landing and Field Carrier Landing Practice (FCLP). During arrestment, friction and thermal loads are generated as the tailhook engages and slides against the arresting cable (cross deck pendant). Currently employed legacy alloys and coatings for arresting gear tailhook components exhibit challenges in manufacturing relating to variable production yield/reject rates and associated cycle time and costs. The objective of this effort will be to investigate, develop, and demonstrate innovative cost effective materials concepts for the arresting gear tailhook, with the intent of obtaining an alternative material which would not require wear and thermal resistant coatings. Also, the alternative material should be capable of satisfying the structural design requirements of the current tailhook (currently 4330V).

PHASE I: Design and develop an innovative approach for alternative arresting gear tailhook materials. Demonstrate feasibility through the fabrication and testing of a limited number of specimens.

PHASE II: Demonstrate and evaluate material on representative components. Demonstration should consider appropriate geometry and performance requirements of arresting gear.

PHASE III: Transition material demonstration package for commercialization and implementation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Though this effort is focused towards the unique performance needs of the arresting gear tailhook components, such advancements in wear resistant materials may be employed to other military and commercial aircraft (as well as ground based) assets.

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4. Additional information provided by TPOC includes diagram, photos, and additional Q&A. (updated 8/18/09) And the Word doc was re-uploaded to SITIS.

KEYWORDS: Wear Materials; Arresting Gear; Tailhook; High Strength Alloys; Manufacturing; Cost

N093-176 TITLE: Wire Restraint Devices

TECHNOLOGY AREAS: Air Platform, Electronics, Weapons

ACQUISITION PROGRAM: PMA-261, H-53 Heavy Lift Helicopters Program

OBJECTIVE: Develop innovative wire restraint concepts to replace existing tying tape (tie string) and plastic cable tie straps (zip ties).

DESCRIPTION: Wiring restraint devices are used on all DOD aircraft. Existing restraint methods are limited to flexible glass, polyester tying tape or plastic cable straps. Failure of plastic cable straps is common, reducing physical support for the wiring system, exposing wire bundles to excessive movement and potential damage, and creating a potential hazard for foreign object damage (FOD) inside the airframe. Tying tape is preferred due to the limitations of plastic cable straps including their ability to function in high-temperature and high-vibration locations; effects of their exposure to ultra-violet light; strap failures that would cause the restraint to foul mechanical linkages or fall into mechanical parts; and material degradation in severe wind and moisture problem locations (wheel wells, wing folds, and other areas exposed to the environment). However, the preferred tying tape is labor intensive, requires greater skill to properly install and is difficult to install in tight places.

New freestanding wire restraint concepts should be capable of operating in high-temperature and high-vibration locations; not be affected by exposure to ultra-violet light; be easily and quickly installed in tight locations; and operate in severe wind and moisture problem locations (wheel wells, wing folds, and other areas exposed to the environment). Restraint performance should meet or exceed the elongation, breaking strength and slip resistance of finish C for tying tape or type 1 for plastic straps. If an install tool is necessary, it should be similar in size to existing cable strap install tools. New and existing materials will be considered.

PHASE I: Develop a suitable approach for durable, easy-to-install wiring restraint devices. Validate the approach analytically and provide simulation or modeling test data that would validate the approach.

PHASE II: Design, develop, and demonstrate wiring restraint device technology taking into account the aging characteristics of the material and damage potential to wire insulation over time under vibration. Conduct testing to demonstrate capabilities.

PHASE III: Prepare wiring restraint device samples for qualification testing and submit to qualifying activity. Transition the technology to air vehicle prime manufaturers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The currently available wiring restraint devices are used both in commercial and military aviation. The issues of lacing tape and plastic cable straps are common to both the commercial and military sectors. In addition, ships, submarines, and other applications using aerospace type wiring restraint devices have the same wiring chafing issues related to wiring restraint devices.

REFERENCES:
1. Cynthia Furse and Randy Haupt, "Down to the Wire," Utah State University

2. Preempting Aircraft Wiring Failures, AFRL Information Directorate, Information Technology Division, Dynamic Command and Control Branch, Rome, NY

3. Testimony of Bernard Loeb, Director Office of Aviation Safety, NTSB, regarding Aging Aircraft Wiring, September 15, 1999

KEYWORDS: Wiring; Restraint Devices; Plastic Cable Straps; Lacing Tape; Aircraft and Electrical; Zip Tie

N093-177 TITLE: <u>Advanced Data Compression Algorithm and Compressor-Decompressor (CODEC) Offload Engine for Aircraft Launch and Recovery Equipment (ALRE) Health Monitoring Support</u>

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: Aviation Data Management and Control System (ADMACS)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop advanced data compression algorithm(s) and bandwidth utilization offload engine that will enable very large amounts of data to be transmitted in bandwidth-limited scenarios from ship to shore.

DESCRIPTION: The U.S. naval vessel of the future will require a much lower level of manning than current vessels, requiring significant levels of automation to attain those levels. High levels of automation increase the demand on data/information access and transfer of data. Performance engineers support maintenance teams in theater over distances identifying and resolving equipment and maintenance problems that have a direct effect on Fleet operational availability.

The volume of data that can be generated by emerging sensors is staggering. For example, a single sensor data collection was 10 MB for just 6 seconds of collection time. Bandwidth in tactical networks is extremely limited and the large amount of data generated by older compression technologies can saturate the network, limiting the amount of data that can be transmitted at any given time. Without bandwidth optimization, downloads and transfers would take significantly longer and create network bottlenecks. The low bandwidth constraint means that a constant, undisciplined, uncontrolled “push” of information is not supportable by the ship to shore communication systems. The constraint places a premium on careful management of information flow, both by application and network layers. By simultaneously optimizing bandwidth utilization, processor performance, and data compression the desired solution should reduce latency, enhance reach back capabilities, and provide “lossless data.” Lossless data compression is a class of data compression algorithms that allows the exact original data to be reconstructed from the compressed data. The solution should work with commercial off the shelf (COTS) products, and open source database products existing replication engines, to minimize custom coding.

Mitigation of these communication problems requires compression of the operational and sensor data, optimal transmission of the signal(s) across telecommunication networks, and rapid decompression of the signal(s) by the remote shore based services. The solution must reliably operate over a range of bandwidths and network configurations. It must allow the administrator to manage or tune the service provided based on available communication capabilities. The developed offload engine should be capable of operating at low data rates and be able to rapidly recover from periods of high packet loss. For the purposes of this project assume that there is no control over the physical network layer. Algorithms and the bandwidth offload engine must be capable of being utilized independent of the quality of service available (e.g., amount of bandwidth available or network availability). To properly control information flow, the solution will require continuous knowledge of network performance data, in particular, average session delay and average session throughput.

PHASE I: Develop a conceptual design of a ship to shore based offload engine and demonstrate feasibility through analysis or limited laboratory demonstrations. Develop a concept of operations and provide defendable estimates for cost, reliability and maintainability.

PHASE II: Develop a detailed design and prototype based on the Phase I conceptual design that can demonstrate optimized ship-to-shore data delivery and network utilization. The design should mitigate the impact of latency and communications degradation.

PHASE III: Design, produce, test and evaluate the first production model of a fully integrated Aircraft Launch and Recovery Equipment (ALRE) data transfer engine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New compression and network optimization technology can mitigate bandwidth costs and improve the overall quality of service while providing a scalable tool that clearly benefits the private sector in such areas as healthcare, law enforcement, maintenance support and other entities requiring data transfer from net-centric systems over low bandwidth networks.

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2. Motion Imagery Standards Board, MISB Standard 0107, "Bit and Byte Order for Metadata in Motion Imagery Files and Streams", 11 October, 2001 - http://www.gwg.nga.mil/misb/docs/MISP45.pdf

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KEYWORDS: CODEC; Data Compression; Sensors; Future Combat Systems (FCS); Algorithms; Bandwidth-Limited Data Transmission

N093-178 TITLE: Innovative Concepts for Lightweight, Low-Cost, High Temperature Turbine Components

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Space Platforms

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop innovative concepts for lightweight, low-cost, high temperature turbine components that are of complex shape and capable of surviving 2200 degrees Fahrenheit or greater as required for hot-section non-rotating aero-turbine engine applications.

DESCRIPTION: In order to meet increased mission demand for naval aircraft, gas turbine engines require lighter weight and lower cost components that are durable at high temperatures. To help satisfy this demand, low-cost, high temperature concepts for excellent shape forming capability are needed. Proposed solutions are for application to complex shaped non-rotating (stationary) components in small aero-turbine engines, as utilized in naval aircraft propulsion and power systems. The proposed concepts should exhibit most of the following characteristics:
- Able to replace the superalloys with domestically sourced elements
- Lightweight with densities lower than superalloys
- Easy to fabricate to near-net solid and hollow thin-wall shapes
- Easily machined to complex curvatures and tight tolerances
- Posses fracture toughness sufficient to avoid brittle behavior & excellent impact damage tolerance
- Potential to live in turbine engine environments of 2200 degrees F or greater
- Erosion, corrosion, and oxidation resistance
- Potential for low coefficient of thermal expansion, below superalloy expansion rates
- Sufficiently high thermal conductivity to not be considered an insulator or barrier

The proposed concept are expected to be prototypically proven in hot vanes and outer shrouds, in both cooled (hollow) and un-cooled (solid) configurations. The Navy is seeking novel alternatives to state-of-the-art superalloys and commercial off the shelf CMC's.

Coordination with military turbine engine manufacturers is highly encouraged.

PHASE I: Develop concepts for lightweight, low-cost, high temperature turbine components that are of complex shape and capable of surviving 2200 degrees Fahrenheit or greater as required for hot-section non-rotating aero-turbine engine applications. Demonstrate feasibility of the proposed approach through analysis and/or limited testing.

PHASE II: Fully develop the identified concept from Phase I and produce a prototype component for limited bench type testing.

PHASE III: Fully develop and qualify concepts. Commercially produce lower-cost improved components for turbine engines used by US Navy, DOD, and civil markets.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology is directly transferable to current and future, military and commercial, gas turbine engine programs or systems that use superalloys for high-temperature resistance.

REFERENCES:
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2. http://www.materials.drexel.edu/max/MaxPhases.htm

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KEYWORDS: Gas Turbine; Materials; Hot Section; Manufacturing; Super Alloys; Ceramics

N093-179 TITLE: Ceramic Matrix Composite Parts Marking

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I

OBJECTIVE: Develop and demonstrate technologies to mark ceramic matrix composite parts for tracking in process and in service.

DESCRIPTION: Ceramic matrix composites (CMCs) are increasingly being considered for a variety of turbine engine and other hot structure applications, both for military and commercial applications. Compared to current materials used in these applications, CMCs offer potential improvements in durability, as well as higher temperature capability and reduced weight. Many aspects of CMC technology and manufacturing are immature. Processes, as routine as parts marking, are complicated for CMCs given the high temperature exposures they are subject to during processing and in service. Rapid, reliable, and cost effective parts marking technology is necessary for in-process tracking and parts flow optimization as well as in-service parts tracking.

CMCs fabricated by the polymer infiltration and pyrolysis (PIP) technique are subject to multiple infiltration and pyrolysis cycles during fabrication. Most existing marking technologies do not appear to survive the high temperature fabrication and application temperatures or are degraded during the various CMC processing steps. The desire is to mark the parts in the green state (before the first pyrolysis cycle) and be able to track them through subsequent infiltration and pyrolysis cycles, as well as to provide for tracking of the parts in service. Viable candidate approaches must be able to withstand CMC processing and application temperatures of up to at least 1200C and must not damage the CMC, alter its dimensions, or otherwise result in property degradation. Application techniques which are rapid, low cost, and automated are desired, especially techniques that allow for automated scanning of marked parts. Remarking of parts part way through the processing is a possibility, if marks are found not to survive all of the PIP cycles.

Similarly, CMCs fabricated by processing methods other than PIP, which may not be marked until the processing is complete, require marking to enable tracking of the parts in service.

Teaming with an engine company and CMC manufacturer is highly recommended to ensure that the technology and application technique is suitable for the identified material and application of interest, could be applied in a manufacturing environment, and would provide the required information.

PHASE I: Develop and demonstrate the feasibility of a CMC marking technique for in-process and/or in-service parts tracking and its ability to survive high temperature exposure/processing. Demonstrate the ability to automatically scan marked parts if appropriate.

PHASE II: Develop and optimize a prototype of CMC marking technique from Phase I. Demonstrate the use of the technology in the manufacturing environment to mark parts/track parts. Demonstrate the ability of the mark to be retained through the fabrication process as applicable. Demonstrate the ability to track parts in service through multiple high temperature exposures.

PHASE III: Transition marking technology for use on military platforms and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: CMCs are being considered for a variety of commercial applications including engines, hot structures, wear, and corrosion control. The technology developed here will be broadly applicable.

REFERENCES:
1. Adams, M.T. and Aspenns, G.D. "Method for direct parts marking composite materials." US Patent App 20040137203, http://www.wikipatents.com/apps/20040137203.html

2. http://zebulonimages.com/pdf/archer.pdf

KEYWORDS: high temperature; parts marking; ceramic matrix composites; scanners; polymer infiltration; pyrolysis

N093-180 TITLE: Corrosion Resistant Non-Toxic Coatings for High-Strength Arresting Gear Tailhook Components

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I

OBJECTIVE: Develop and demonstrate non-toxic coatings for the protection of high-strength alloy steels employed in arresting gear tailhook components.

DESCRIPTION: Cadmium is the employed legacy coating for the protection of arresting gear tailhook components in the aggressive service environments, and in general, is applied to protect surfaces not intended for direct contact to arresting cable (cross deck pendent). Heavy metals such as cadmium have been shown to exhibit health risks, which have resulted in the reduction in permissible exposure limits (PEL). To address the challenges associated with coating corrosion prevention and coating performance, a non-toxic coating for the protection of high-strength alloy steel is needed. The objective of this effort will be to investigate, develop, and demonstrate a non-toxic corrosion preventative coating for high-strength alloy steel.

PHASE I: Design, develop and prove feasibility of a corrosion resistant, non-toxic coating for tailhook components. Demonstrate feasibility through the fabrication and testing of a limited number of specimens.

PHASE II: Continuing efforts from Phase I, refine coating design and development. Perform prototype demonstration of corrosion preventative coating on representative components. Demonstration should consider appropriate substrate material, geometry, performance requirements, and environmental exposure of arresting gear.

PHASE III: Transition coating technology for military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Though this effort is focused towards the unique performance needs of the corrosion prevention of arresting gear tailhook components, such advancements in corrosion prevention may be employed in the protection of other military and commercial aircraft (as well as ground based) steel assets.

REFERENCES:
1. J. H. Ouyang and S. Sasaki. "Effects of Different Additives on Microstructure and High-Temperature Tribological Properties of Plasma-Sprayed Cr2O3 Ceramic Coatings." Wear, volume 249, Number 1, April 2001, pp. 56-66.

2. Singh, H., Puri, H., and Prakash, S. "Some studies on hot corrosion performance of plasma sprayed coatings on a Fe-based superalloy." Surface and Coatings Technology, volume 192 (2005), pp. 27-38.

3. Additional information provided by TPOC includes diagram and photos.

4. High-Strength Steel Joint Test Protocol, July 31, 2003, 62 pages.

KEYWORDS: Cadmium; Corrosion Preventative Coatings; Arresting Gear; High Strength Alloys; Tailhooks; Non-Toxic Coatings

N093-181 TITLE: Thrust Measurement Model for Engine Test Cell Environment

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop an innovative and robust model based method for calculating thrust in a gas turbine engine test cell environment.

DESCRIPTION: Test cell thrust measurement systems for gas turbine engines are excessively noisy due to acoustic energy, test stand dynamics and other ambient conditions. This noise makes the small transient and dynamic signals that are important for engine analysis and flight certification extremely difficult to isolate. Providing a clean thrust or similar dynamic signal to match the engine performance model is key to enhancing engine test cell thrust measurement capability.

An innovative standalone software tool is needed to monitor and accurately replicate, in real-time, the performance of a jet engine under test. It is visualized that this tool would operate in an open loop fashion, receiving real-time parameters of engine inlet conditions, commanded parameters, fuel flow rate, and variable geometry positions, to produce a real-time stream of representative thrust and other modeled engine parameters of choice. When required, this model should be able to “stand in” for real engine thrust measurements during periods of noisy data collection, ensuring good continuous data for small transient and dynamic signals. This will provide more accurate engine analysis and flight certification test results. Ideally, this model will have already been validated against the engine under test. It is desired that the model be in the Numerical Propulsion System Simulation (NPSS) format and have the ability to allow tuning to determine or match engine component deterioration. Coordination with a military engine manufacturer is highly encouraged.

PHASE I: Identify, define, develop, and demonstrate a conceptual design of the proposed technology.

PHASE II: Refine, construct and demonstrate the operation of a prototype. Provide a detailed plan for incorporation of the proposed technology in a test cell environment.

PHASE III: Transition the developed technology for fleet and commercial use. Provide a detailed supportability plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Current test cell tools for measuring and predicating performance in the cell are limited and often not robust to test cell disturbances. The commercial industry would easily benefit from application of this tool in commercial test cells.

REFERENCES:
1. Scott M. Jones. March 2007. "An Introduction to Thermodynamic Performance Analysis of Aircraft Gas Turbine Engine Cycles Using the Numerical Propulsion System Simulation Code". NASA Glenn Research Center, Cleveland, Ohio NASA/TM—2007-214690

2. K.I. Parker, J.L. Felder, T.M. Lavelle, C.A. Withrow, A.Y. Yu, and W. Lehmann, William. February 2004. "Integrated Control Modeling for Propulsion Systems Using NPSS."NASA Glenn Research Center, Cleveland, Ohio NASA/TM—2004-212945.

3. Robert J. Jeracki. July 1998. "Model Engine Performance Measurement From Force Balance Instrumentation". Lewis Research Center, Cleveland, Ohio NASA/TM—1998-208486

4. Dennis E. Culley and Alireza R. Behbahani. September 2008. "Communication Needs Assessment for Distributed Turbine Engine Control". NASA Glenn Research Center, Cleveland, Ohio; NASA/TM—2008-215419.

KEYWORDS: gas turbine; modeling and simulation; engine model; engine performance; tunable test cell; NPSS

N093-182 TITLE: <u>Multi Directional Low Airspeed Indicator for Rotary Wing Aircraft</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Human Systems

ACQUISITION PROGRAM: PMA-299 H-60 Helicopter Program, ACAT 1

OBJECTIVE: Develop a multi directional, accurate, low airspeed indicator for rotary wing aircraft.

DESCRIPTION: Current traditional airspeed indicator systems are one directional (forward speed only) and not very accurate in low speed flight. The MH-60S Airborne Mine Counter Measures (AMCM) program needs an accurate multi-directional low airspeed indicator to improve performance in continuous-low-speed missions such as towing mine sensors. Such multi-directional low airspeed indicators of sufficient consistent accuracy for AMCM Towing missions, and capable of reliable integration with existing embedded navigation aids do not exist at this time.

The need to know the accurate helicopter velocity at relatively very low portions of the velocity spectrum enhances the crew situational awareness and significantly reduces pilot workload in critical AMCM towing operations. The ability to provide accurate, consistent, and reliable low airspeed indications to the aircrew and mission systems will significantly enhance low altitude helicopter-over-water missions and ground missions where visual objects are not in the pilot's visual scan for speed reference.

AMCM crew towing operations are difficult to maintain track and control when towing AMCM sensors. Determining wind correctional angles to maintain accurate track in a sweep pattern with strong crosswinds is very challenging and significantly increases pilot workload. Maintaining an accurate ground track when turning upwind to downwind, without visual reference objects at sea, especially at low airspeeds, is an extremely difficult task. An improved low-airspeed indicator, in combination with ground speed indications from onboard Embedded GPS/INS (Global Positioning System/ Inertial Navigation System) EGI navigation systems, could provide the aircrew with additional information for improved tracking over potential mine fields. Other low altitude over-sea, low-airspeed scenario, helicopter missions could benefit as well. AMCM workload issues are complex and any instrumentation improving the situational awareness during mission critical tasks while decreasing the crew work load in a stressful environment is welcomed. A seamless integration of an improved low-airspeed sensor with the air frame and with other navigational aids such as Embedded GPS/INS , and information displayed to the aircrew are desired goals.

PHASE I: Research and develop new concepts and sensors that can accurately determine low multi-directional airspeed in a rotor wash environment. Develop a new combined sensor(s) that can accurately measure low forward, low side drift and low rearward velocities. Research and identify new concepts and methods to provide the air crew with visual, sensual or aural indications of low velocity information. Investigate ways to integrate/install into existing USN helicopter weapons systems with minimal total ownership costs. These concept(s) could include a laboratory demonstrations, simulations, models or demonstrations on a helicopter.

PHASE II: Design, develop and demonstrate an operational prototype of a low speed accurate multi directional airspeed indicator system for rotary aircraft.

PHASE III: Produce a suitable multi-directional airspeed indication system for MH-60S AMCM aircraft production aircraft. Install, test and operationally demonstrate it on the MH-60S AMCM platform. Transition the technology to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial aviation industry will benefit from improved airspeed sensors, enhanced flight operations, increased safety, low cost, and multi-directional velocity indicators.

REFERENCES:
1. Rotorcraft Flying Handbook. FAA Manual#H-8083-21. 2000.

2. NATOPS Flight manual Navy Model MH-60S Aircraft

KEYWORDS: low airspeed indicator; pilot-static system; wind drift; AMCM workload; cross wind determination; side drift

N093-183 TITLE: <u>Innovative Foreign Object Damage (FOD) Detection and Identification Technology for Military Turbine Engines</u>

TECHNOLOGY AREAS: Air Platform, Space Platforms

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop technology that identifies the particular location and magnitude of foreign object damage and integrate the solution with the repair and blending of integrally bladed rotors (IBRs)/blisks and stationary airfoils.

DESCRIPTION: State-of-the-art military turbine engines incorporate IBR(s)/blisks, which are one-piece components consisting of blades and a disk (blisks), in the compression system. The purpose of these IBR(s)/blisks is to reduce weight through part count reduction and improve performance and maintainability. FOD is the primary driver for unscheduled engine removals in today’s fleet environment. To maintain affordability and fleet readiness, the need for identifying the FOD event and location and the magnitude of the FOD damage must be assessed while the engine is still on wing. Current methods using blendable boroscopes are moderately effective, but they can be only be operated by experienced and specialized technicians, which adds complexity to aircraft maintenance. A novel and enabling FOD detection technology that will permit identification on both rotors and stators when the engine is mounted on wing and can be used by field technicians to identify and assess the extent of damage and location is needed. The technology should be able to meet these requirements in addition to addressing affordability and maintainability requirements of advanced military propulsion power plants. A novel sensor technology that could integrate FOD detection with vibration, clearance and blade/vane mode identification would be intended outcome of this initiative.

PHASE I: Conceptualize, evaluate, and determine the feasibility of FOD detection, magnitude and location on stationary and rotating airfoils. Demonstrate cost-effectiveness of the proposed technique. Identify hardware and tools needed for the procedure. Evaluate improvements over current identification and repair methodologies.

PHASE II: Build a prototype and demonstrate the technique and subsequent improvement in engine environments. Address potential adverse affordability issues and identify mitigating solutions.

PHASE III: Integrate the technology into maintenance procedures at an original equipment manufacturer (OEM) or depot.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The ability to repair fielded turbine engines at low cost is desirable for the commercial sector. Expensive and redundant repairs could be minimized by employing this technology to reduce time off wing of turbine engines.

REFERENCES:
1. W. Strack, D. Zhang, J. Turso, W. Pavlik, I. Lopez. "Foreign Object Damage Identification in Turbine Engines." NASA TM 2005-213588; Army ARL–MR–0611, March 2005.

2. J.A. Turson, J.S. Litt. "A Foreign Object Damage Event Detector Data Fusion System for Turbofan Engines." NASA TM 2004-213192; Army ARL-MR-3201, August 2004.

KEYWORDS: Integrally Bladed Rotor; Blisk; Foreign Object Damage; Damage Detection, Turbine Engine

N093-184 TITLE: Innovative Bearing Concepts For High Speed Rotating Machines

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA265, F-18 Super Hornet, Hornet, and Growler Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate bearing concepts with improved reliability for high speed rotating machinery applicable to naval aircraft environmental control systems.

DESCRIPTION: The F-18 and other military platforms utilize environmental control systems in a variety of configurations. These systems contain rotating components that operate at velocities between 60,000 and 100,000 rpm and weight between four to eight pounds. Bearings that are currently being utilized exhibit degradation prior to the expected end of life. The current bearings are hydrodynamic air bearings, and consist of both journal and thrust bearings. The premature degradation is due to contamination or bearing overload. Current environmental control system assemblies (housings, turbine, compressor, bearings, and shaft) weigh approximately 15 pounds and provide approximately 40,000 Btu/hr of cooling. Innovative approaches are required that provide alternatives to the existing configurations.

Innovative concepts should take into consideration the unique naval operating environment such salt-fog and G-loading from carrier arrestments and launches. The proposed concept should also be compact, light weight, and oil free.

PHASE I: Develop innovative bearing concepts that provide improved durability for high speed rotating machinery applicable to naval aircraft environmental control systems. Demonstrate the feasibility of the developed approach through analysis or limited concept testing.

PHASE II: Fully develop the detailed designs for the bearing concept. Produce a prototype bearing system and demonstrate the capability of the bearing to perform its functions in the high speed operating environment.

PHASE III: Perform complete qualification and certification of the developed bearing concept. Transition the approach to F-18 and other high speed machinery applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advanced bearing concepts have the potential to transition to commercial industry turbomachinery.

REFERENCES:

1. "Oil-Free Turbomachinery Program - Advanced Foil Bearings", http://www.grc.nasa.gov/WWW/Oilfree/bearings.htm

2. B. Dykas and S.A. Howard, "Journal Design Considerations for Turbomachine Shafts Supported on Foil Air Bearings", Society of Tribologists and Lubrication Engineers, Oct-Dec 2004

3. C. DellaCorte and M.J. Valco (2002), "Load Capacity Estimation of Foil Air Jounal Bearings for Oil-Free Turbomachinery Applications", (NASA/TM-2000-209782), (ARL-TR-2334), http://gltrs.grc.nasa.gov/reports/2000/TM-2000-209782.pdf

4. NASA - Creating a Turbomachinery Revolution Fact Sheet, FS-2001-07-014-GRC, "Research at Glenn Enables an Oil-Free Turbine Engine", http://www.nasa.gov/centers/glenn/about/fs14grc.html

KEYWORDS: bearing; turbomachinery; oil-free; high-speed; contamination-tolerant; maintenance-free

N093-185 TITLE: Robust Pressure Transducer for Propulsion Control Systems

TECHNOLOGY AREAS: Air Platform, Space Platforms

ACQUISITION PROGRAM: PMA-276 Light Attack Helicopter Program

OBJECTIVE: Develop innovative hi-fidelity, environmentally robust, and low cost pressure transducers for aircraft engine control systems.

DESCRIPTION: Pressure transducers are a critical component in the control of aircraft gas turbine engines. However, these devices are subject to extreme environmental conditions and are routinely exposed to combustion contaminants – all of which reduce transducer reliability and accuracy. In particular, contaminated air flowing inside the sensor body creates a buildup of carbon and other deposits on the sensing mechanism reducing accuracy, lowering engine performance, and ultimately resulting in sensor failure.

The goal is to develop innovative technology that provides hi-fidelity, environmentally robust, contaminant resistant, drift resistant, and low cost pressure transducers that can interface with current technology aircraft engine controllers, i.e. Full Authority Digital Engine Controllers (FADECs). The technology should be applicable to all pressure sensors used for gas-turbine engine control, with the main focus being compressor inlet, compressor discharge, and turbine exhaust. Coordination with military engine manufacturer is highly encouraged.

PHASE I: Identify, define, and develop a conceptual design of the proposed technology. Develop detailed analysis of predicted performance and prove feasibility.

PHASE II: Construct and demonstrate the operation of a prototype and conduct cradle-to-grave life cycle and environmental testing. Provide a detailed plan for practical deployment of the proposed technology, such as incorporating the technology to fleet supply lines and the training needed for fleet maintainers, as well as the associated implementation and supportability costs involved. Perform a risk assessment of the proposed technology.

PHASE III: Transition the developed technology for fleet use, and provide a detailed supportability plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Harsh engine operating environments are also prevalent in the commercial air travel industry. The commercial industry would benefit from improvements to engine control systems via more robust pressure transducers.

REFERENCES:
1. "High Temperature Dynamic Pressure." Propulsion Instrumentation Working Group Sensor Specifications. http://www.piwg.org/sensor/sensor_hdpressure.html#table

2. A.D. Kurtz, J.W. Chivers, A.A. Ned, and A.H. Epstein. “Sensor Requirements for Active Gas Turbine Engine Control." RTO A VT Symposium on Active Control Technology for Enhanced Performance Operational Capabilities of Military Aircraft, Land Vehicles and Sea Vehicles, Braunschweig, German-,8-11 May 2000.

KEYWORDS: pressure transducer; engine control system; pressure sensor; FADEC; turbine engine operability; combustion contaminants

N093-186 TITLE: MH-60S Vertical Replenishment Object Proximity Warning System

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-299 MH-60S Production ACAT 1

OBJECTIVE: Develop a Vertical Replenishment (VERTREP) object and ground proximity warning system.

DESCRIPTION: Traditional ground proximity warning systems for rotary wing aircraft are a derivative from land based fixed wing aircraft. Installation and operation of derivative Ground Proximity Warning Systems (GPWS) on sea based rotary wing naval aircraft have not been very successful in providing accurate coverage in sea operations and scenarios. MH-60S VERTREP operations present a challenge to successfully integrate a faultless object proximity warning system using traditional sensors and algorithms. Current GPWS sensors are inadequate and software algorithms insufficient to detect ship deck edge/interfaces, increase reliability and become more user friendly as an aircrew situational tool during VERTREP operations. An innovative sensor solution to detect object/terrain interface(s) in a low-to-high contrast environment will assist in resolving outstanding MH-60S GPWS deficiencies discovered during flight testing. Sensors should have very high detection rates and low false alarm rates. New concepts could include a laboratory demonstration, simulation or model of the sensor(s) and/or software algorithms and the planned integration into sea based rotary wing aircraft.

Research and develop new technology sensors that are suitable for new or next generation object proximity warning systems. Develop reliable faultless sensor software that is compatible with new Object Proximity Warning System (OBWS) technology sensors and MH-60S VERTREP operations. Develop a cockpit aircrew interface concept that provides reliable object proximity warnings/information and increases air crew situational awareness in VERTREP operations.

PHASE I: Research and develop new technology based innovative terrain/sea/object sensors Determine the feasibility of developing new open architecture software algorithms that use new innovative sensors to improve the accuracy and effectiveness of a OPWS in a VERTREP environment.

PHASE II: Develop and demonstrate an operational prototype of a VERTREP OPWS sensor(s) and software for USN sea based rotary wing aircraft.

PHASE III: Produce a suitable OPWS for MH-60S aircraft production aircraft. Install, test and operationally demonstrate it on the MH-60S platform. Documentation to be developed includes requirements, designs, testing, transition, install, and user documents.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improved algorithms and sensors for next generation GPWS systems

REFERENCES:

1. MH-60S GPWS System Specification, SS-MH60-GPWS-v1.0 Rev. A dated 28 Mar 2005. Spec will be available on SITIS website, http://www.dodsbir.net/sitis/

2. Jenson, David. "EGPWS: Look What It Can Do Now." Aviation Today. 1 November 2000. http://www.aviationtoday.com/av/categories/bga/12904.html

KEYWORDS: Ground Proximity Warning Systems; Sensors; Algorithms; Vertical Replenishment; Hazards; Obstructions

N093-187 TITLE: Innovative manufacturing processes and materials for affordable Transmit/Receive (T/R) module Production

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: NON-ACAT X-Band and S-Band Radars and EW Arrays

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Innovative materials, manufacturing processes and/or packaging technologies are needed to minimize material/manufacturing costs of Radar/ EW Transmit/Receive(T/R) modules for NAVY IWS shipboard Phased Array Radar/EW Electronically Steered Arrays (ESAs) having an anticipated 20 year service life.

DESCRIPTION: Reduction in T/R module packaging cost is essential to fielding today and tomorrows large high power phased array radars and EW systems. Low cost module packaging and interconnection substrates are required that can satisfy the naval shipboard environment for 20 years deployed service for high power microwave T/R modules. Affordable high reliability T/R module packaging technologies are needed, material and manufacturing costs must be minimized while providing the Radar/EW system performance that is required. The materials, manufacturing processes and/or packaging technologies being developed here must provide reliable operation and address module design factors such as thermal coefficient of expansion matching, thermal dissipation and electrical performance efficiencies required by state of the art WBG T/R modules that are to be used in NAVY IWS shipboard Phased Array Radar/EW Electronically Steered Arrays (ESAs) having an anticipated 20 year service life. Metric for success will be no degradation, improvement is desired, of electrical performance (gain, current consumption, input/output impedance, S-parameters) and maintain environmental EMI, temperature and moisture ingress/absorption protection needed while reducing the overall module assembly complexity and cost by 20 percent.

PHASE I: Conduct innovative R&D to design, model, and/or develop materials, manufacturing processes and/or packaging technologies meeting the intent of this topic. Provide a feasibility report with recommendations for proposed solution with the resolved tradeoffs.

PHASE II: Complete needed R&D to develop manufacturing processes and prototype test modules with the materials, manufacturing processes and/or packaging technologies identified in Phase I. Evaluate stable MMIC/ T/R module electrical performance over anticipated operational temperature ranges and meet, or exceed this topics stated objectives. Establish critical new manufacturing processes and test hardware performance to evaluate feasibility of the developed technologies and manufacturing processes to provide production ready T/R Modules that will satisfy the operational requirements of a Navy IWS Radar or EW system. In addition, conduct preliminary cost modeling to show that the technology is cost competitive with current State of the Art (SOA) T/R module production processes.

PHASE III: Establish manufacturing processes and quality controls to provide production quality materials, manufacturing processes and/or packaging technologies integrated into T/R modules needed by Navy IWS Radar and EW applications. Manufacture T/R modules to evaluate final processes and conduct electrical and environmental performance testing of the technology. Conduct cost modeling to show that the developed technology is cost competitive with current State of the Art (SOA) T/R module production processes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New and innovative T/R module materials, manufacturing processes and/or packaging technologies that can provide lower cost T/R modules will have applications in other commercial and government radars and RF equipment as well as on numerous military radar and EW systems.

REFERENCES:
1. "GaAs MMIC Reliability Assurance Guideline for Space Applications", S. Kayali, G. Ponchak, R.Shaw, JPL Publication 96-25.

2. Bahl, I., and P. Bhartia, Microwave Solid State Circuit Design, John Wiley & Sons, Inc., New York, 1988.

3. Electronic Materials Handbook, Volume 1 Packaging, ASM International.

KEYWORDS: Transmit/Receive (T/R) Modules, Electronics packaging; MMIC; Radar; EW;

N093-188 TITLE: <u>Image Fusion for Submarine Imaging Systems</u>

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: POR is Advanced Submarine Combat Systems Development

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate innovative image fusion algorithms for submarine imaging systems.

DESCRIPTION: Haze, fog, and other atmospheric conditions often make it difficult to detect objects in periscopes. This can increase risk to the submarine as it comes to periscope depth and operates both at periscope depth and when surface navigating. Modern submarine imaging systems contain several modalities of imaging sensors available for use to the sailor including visible color, near infrared (NIR), short-wave infrared (SWIR), and mid-wave infrared (MWIR). In certain situations, each modality may be used to extract different information from the same scene. This is overly labor and time intensive. Innovative image fusion technologies that will combine multiple modalities in real time with low latency will yield increased scene information while easing the burden on the sailor on having to constantly switch between modalities. Challenges include combining video from sensors with various dynamic ranges, spatial resolutions, and frame rates. Another challenge is that the optical train for the various modalities may not be co-located on the mast, thereby leading to parallax issues. Sophisticated image registration algorithms are critical to enable the fusion of imagery from these modalities. Currently available image fusion algorithms that use overlays or image addition will not be adequate due to the above issues. This topic seeks intelligent methods of combining modalities that will provide the periscope operator with increased ability to detect, track, and identify objects of interest in difficult environmental conditions while reducing the clutter caused by waves and white caps. The preferred implementation of this set of image fusion algorithm(s) is in the form of a software program capable of being run on general purpose processors.

PHASE I: Perform the R&D needed to identify and define a promising conceptual image fusion solution for a selected submarine imaging system. Specific theory/algorithms should be identified to address all steps in the image fusion process. Document the conceptual design in a final Phase I report.

PHASE II: Complete the required R&D to develop and validate image fusion algorithm(s) that will operate in real time on stand-alone hardware with minimal latency, ready for a land based evaluation of the imaging system selected for Phase I. Document the design and test results in a final report.

PHASE III: If successfully demonstrated in Phase II, integrate the solution on a submarine for at-sea testing. Fleet implementation may be accomplished through Technology Insertion (TI) upgrade to existing submarine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Harbor and border surveillance for homeland security, law enforcement surveillance, and industrial security are possible commercial applications of such a solution.

REFERENCES:
1. Smith, Moira I. and Heather, Jamie P., “A review of image fusion technology in 2005”, Thermosense XXVII. Edited by Peacock, G. Raymond; Burleigh, Douglas D.; Miles, Jonathan J. Proceedings of the SPIE, Volume 5782, pp. 29-45 (2005).

2. D.A. Fay, A.M. Waxman, M. Aguilar, D.B. Ireland, J.P. Racamato, W.D. Ross, W.W. Streilein, M.I. Braun, "Fusion of multisensor imagery for night vision: Color visualization, target learning and search", 3rd International Conference on Information Fusion, Paris, 2000.

KEYWORDS: Image fusion; Image Registration; Shortwave-Infrared; Mid-wave-infrared; Sensors; Algorithms.

N093-189 TITLE: <u>Smart Power Load-Leveling Control for Energy Efficient, Advanced Distribution Systems</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: NAVSEA21, PMS400F, CAPT Robin Russell

OBJECTIVE: Develop an advanced control system including the associated algorithms and governing methodologies that will provide the capability to monitor and adjust energy generation, energy storage, and system loads for enhanced shipboard performance.

DESCRIPTION: It is anticipated that next generation platforms will require larger amounts of high-quality, clean, on-demand power than the existing fleet. Recent developments in highly-efficient energy generation concepts such as hybrid drive, fuel cells, and waste heat recovery systems are attracting attention as the Navy works to lower current and future fleet operational costs. However, cost, space and weight limitations make it impractical to provide dedicated energy storage for every load. Instead the Navy is seeking to direct the stored and/or generated power to the active loads on as needed basis. If shared generation is properly controlled, the system will serve to reduce fuel consumption and minimize the reactive power present in existing AC distribution systems, while still providing the level of power required to conduct and complete the mission. Currently, the list of power management functions are dispersed in independent system controllers that at times do not communicate in a coordinated fashion to provide an overall system response, do not account for system dynamics that are representative of pulsed loads, and manage loads predominately using a load blocking mechanism to ensure that adequate available generation power is present before a load is energized.

This topic seeks innovative approaches to optimize the synergy between these new potential distribution assets via an integrated monitoring and control system. The integrated system will provide sailors with the ability to automatically configure and manage the distribution assets and ensure 1) maximized use of power generation assets is and 2) sufficient power / redundancy is available to meet mission demands.

Proposed concepts should address the ability to provide the following functions:
1. Able to handle power distribution between current and anticipated energy generation sources.
2. Ensure power quality, availability, and survivability.
3. Proactively and seamlessly respond to large load requests.
4. Awareness of the present distribution configuration and ability to automatically determine the optimal requested load configuration.
5. Assure that each load is properly powered using the best storage / generation assets available to match the demand.
6. Compensate for Integrated Power System (IPS) and hybrid electric drive propulsion dynamics coupled onto the distribution bus.
7. Avoid inducing distribution instabilities during reconfigurations for energy efficiency.
8. Work synergistically with other power algorithms handling dynamics, reconfigurations, etc.

In the near-term this system could be deployed to the existing fleet, integrating with the hybrid electric propulsion / generation system, optimizing the power available from ship's propulsion, ship's service and energy storage sources to maximize efficiency and effectiveness. Future generations of this system may be required to work with a variety of stored and or dynamic energy sources such as fuel cells, flywheels, anti-roll fluid turbines, propellor regeneration and other renewable resources, and handle more demanding load applications with the Navy's next-generation IPS.

PHASE I: Research the potential feasibility of an integrated monitoring and control system that will provide the capability to monitor and adjust energy generation, energy storage, and loads for enhanced shipboard process performance. Provide a functional description of how such a system would operate, and what the associated hardware and software requirements would be. As applicable, research/develop computer models that will demonstrate the feasibility and performance of the proposed concept. Identify potential distributed control strategies that could achieve the desired power quality, availability, and survivability. Establish validation goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Finalize the design concept from Phase I, complete the R&D needed to develop a working solution/theory, and fabricate a prototype in order to evaluate the developed algorithms and strategies. Validate prototype capabilities using laboratory testing and provide results. Demonstrate proposed installation, maintenance, and performance of the monitoring and control system. Develop testing procedures to measure the effectiveness of the system and develop a plan for an installation and testing onboard ship. As appropriate, provide a detailed plan for software certification and validation.

PHASE III: Working with the Navy, install and test at the Land Based Engineering Station in Philadelphia. Provide detail drawings and specifications. Technology will have potential to transition to all US Navy platforms that utilize advanced generation and energy distribution systems for fuel efficiency and high power loads.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Smart distribution systems that optimally manage distributed generation operation will become increasing important to provide facilities with high reliability power for information systems (i.e., sensitive and critical loads) while minimizing energy costs. As these costs continue to rise, typical industrial sites will be relying more on multiple alternative energy sources, such as solar and wind, along with energy storage technologies. In order to maximize the return of investment in alternative energy sources, industry will need the capability for controlling assets based on efficiency and life cycle costs.

REFERENCES:
1. Borbely, A. and Kreider, J.F. “Distributed Generation: The Power Paradigm for the New Millennium”, CRC Press, Boca Raton, FL, 2001.

2. Ackermann, T. Knyazkin, V., “Interaction Between Distributed Generation and the Distribution Network: Operation Aspects”. Transmission and Distribution Conference and Exhibition. 2002.

3. “Shipboard Electric Power Distribution: AC Versus DC Is Not the Issue, Rather, How Much of Each Is the Issue”; LCDR John V. Amy Jr. PhD, Mr. David H. Clayton and Mr. Rolf O. Kotacka; All Electric Ship 98 Conference.2nd ed., vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15-64.

4. DDG51 Specifications on Control Consoles and Control Systems. (electrical and physical limits)

KEYWORDS: Energy Efficiency; Load Leveling; Distributed Generation; IPS; Electric Ship

N093-190 TITLE: Opportunistic Energy Harvesting

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMS450: VIRGINIA Class submarine: ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Investigate viability of harvesting power from the environment as a means to support wireless sensor systems.

DESCRIPTION: The Navy seeks technologies that will reduce the installation and maintenance cost of sensor systems. One concept is harvesting energy that is required to operate inboard and outboard sensors from electromagnetic energy in the environment. The energy harvested would be used to power the sensor and support wireless telemetry of the data from the sensor. Consideration must be given to the overall system approach and operational aspects of the systems. Ideally sensor systems would require no hull penetrations, power or signal wiring.

The guidelines for the energy harvesting system are:
-- Voltage: 2 to 5 Volts DC
-- Power: 0.1 to 1 Watt
-- Size: equivalent volume of 2 D cell batteries or smaller

PHASE I: Research opportunities to harvest power from the environment to power sensor systems in an effort to minimize or eliminate the need for dedicated wiring. Potential techniques include harvesting energy from electromagnetic fields present in the ship environment. The evaluated techniques should provide realistic energy levels (approx. 0.1 to 1 Watt) relative to the proposed sensor solution. Candidate concepts must address management of the harvested energy to optimize the power balance between the sensor system and the harvesting technique. Determine feasibility of an implementation using analysis and a laboratory demonstration. Consideration must be given to reliability and the operational environment and concept of operations for the proposed system.

PHASE II: Design and develop a scale prototype that can be tested in a representative environment. The prototype should include a complete concept that incorporates power harvesting and sensor operation. A demonstration of the prototype in a laboratory environment will be used to verify that key system performance specifications are met.

PHASE III: Design and develop a full scale prototype system that can be easily integrated and tested on a submarine platform as an early technical demonstration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovations in the area are of universal appeal in industrial applications. There are many examples where local pressure, temperature, and exerted forces are extreme and power transmission is not viable. The ability to tap into these local environmental conditions to supply power enables applications that are not presently possible. Current commercially available energy harvesters produce power in milliWatts. A two orders-of-magnitude increase in output power would benefit many military/commercial applications. This includes submarines, surface ships, unmanned undersea vehicles, petroleum wells and the associated drilling and monitoring processes, undersea cable systems, and high pressure pipe line monitoring.

REFERENCES:
1. Wayne Manges, “The Future of Power Harvesting”, http://www.sensorsmag.com/sensors/article/articleDetail.jsp?id=334636, Sensors Magazine, 13-JUN-2006

2. Mitcheson, P.D.; Green, T.C.; Yeatman, E.M.; Holmes, A.S., “Architectures for vibration-driven micropower generators,” Journal of Microelectromechanical Systems, Volume 13, Issue 3, June 2004 Page(s): 429 – 440.

3. Justin R. Farmer, “A comparison of power harvesting techniques and related energy storage issues,” Masters Thesis, Department of Mechanical Engineering, Virginia Polytechnic Institute and State University, MAY-2007.

KEYWORDS: Power Harvesting, Submarine Systems, Hull Penetrator, Autonomous Powered Devices

N093-191 TITLE: Multi-Material Structures

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: VIRGINIA Class Submarines, NAVSEA PMS450, ACAT I

OBJECTIVE: The basic need is to develop structurally robust methods for transitioning from one form of fiber reinforcement in areas that connect to steel components to areas where the higher stiffness and strength offered by alternate reinforcements can produce a significant weight savings.

DESCRIPTION: Minimizing corrosion is a constant challenge to the ship design community. Fiber-reinforced plastics are generally corrosion resistant; in fact aramid and glass fiber reinforced composites may be fastened or joined with almost any fastener material to metals without fear of galvanic corrosion. Plastics reinforced with carbon fibers can induce galvanic corrosion in the attached metal structures, or metal fasteners. This topic seeks to identify and demonstrate concepts for transitioning between two or more materials in marine composite structures while minimizing galvanic corrosion.

PHASE I: Conduct R&D and analysis to develop concepts for transitioning fiber reinforced materials and demonstrate the feasibility of the concept with respect to its use in the marine composite environment. Prepare a report on the results with recommended concept(s). In addition to structural and galvanic performance, address its manufacturability, and durability aspects in the Phase I option.

PHASE II: Develop and demonstrate the concept at the component level (i.e. a sandwich or stiffened panel and representative joints) showing the performance capabilities of the system. Also demonstrate examples of manufacturability and durability of the system through testing.

PHASE III: Insert the product into a candidate marine application and test as part of other technology demonstrator activities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The material technology developed under this topic could be applied to any sea, land or air vehicle where tailoring physical and/or mechanical properties provides performance improvements required by the system.

REFERENCES:

1. Tsai and Hahn, "Introduction to Composites", Technomic, 1980.

2. Telegadas, "Best Practices for Composite Submarine Non-Pressure Hull Structure", NSWCCD-65-TR-2008/28, Dec 2008.

KEYWORDS: Composites, GRP, glass, carbon, graphite, hybrid, joints, galvanic corrosion

N093-192 TITLE: Real-time Decision Aid for Enhancing Ship's Self-defense

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: Submarine Combat Systems Program Office (PMS425) ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The goal of this project is to research adaptive intelligent distributed computing environment used for submarine training, simulation, and warfare. Specifically, the topic shall address with targeted R&D the high level cognitive and human systems automated control theory algorithms, which will be integrated for a seamless sensor-to commander/warfighter information distribution for new and emerging torpedo countermeasures during hostile encounters, while providing the commanding officer and tracking party a tool set for automatically selecting and presetting these countermeasures for rapid reaction. Additionally the integration and implementation must eliminate the intensive operator interactivity required in this high stress environment and allow for the capability to automatically preset Torpedo Defensive Weapons and Devices from the submarine attack center utilizing existing and newly developed tactics (real time), for organic detection and contact management capabilities, environmental inputs, and navigational inputs.

DESCRIPTION: Currently US submarine onboard self-defense systems suffer from a lack of integration automated workflow, resulting in an extreme unnecessary reliance on mental calculations and approximations to execute pre-planned evasion and counter-fire procedures. During a self-defense scenario, the combination of rapidly changing tactical conditions and high stress make this an error prone evolution with potentially severe consequences. Additionally, the command party attention now focused on mental calculations under current doctrine is not being directed to other necessary considerations such as damage control preparations, long-term evasion or re-engagement plans, or other urgent planning considerations. A cognitive automated capability is critically needed to decrease submarine crew reaction time to detected threats and weapons by providing a reliable and effective HSI capability to automatically identify weapon threats, determine the most effective countermeasure(s) (CM) presets, and rapidly develop a dynamic, in-situ CM deployment and evasion scheme designed to destroy or negate the effectiveness of enemy sub-surface threats and to protect U.S. and coalition forces and assets.

The challenge is to complete the multi-spatial Control theory R&D to provide an integrated near-real-time identification of the threat based on onboard sensor information, and presenting a CM employment plan and evasion scheme to the Officer of the Deck (OOD). Much of the present day guidance to accomplish this task is contained in written guidelines which shipboard personnel must refer to during high stress situations, or have committed to memory. This is already prone to error and dependent on assumptions used to simplify the problem, and as countermeasures continue to evolve with new capabilities available as presets selectable by an operator, this will only become more complicated as options evolve. In addition, defensive weapons employment should be integrated into this formula to provide a rapid counter-fire capability against a hostile adversary. The topic must address an integrated algorithm approach for HSI and workflow for providing current doctrine, updates by appropriate authorities, and local changes authorized by the ship's commanding officer.

PHASE I: Research the control theory, AI, and HSI algorithms needed to support a new system design for an integrated and automated submarine self-defense system that incorporates counter-measure deployment aids, evasion guidance and self-defense weapon presetting thereby eliminating the burden of the operator and increasing the likely hood of a successful evasion. Document the planned design in an unclassified system design document and program plan to support Phase II prototype development.

PHASE II: Design an unclassified prototype and demonstrate a fully automated self-defense architecture/application in a lab/shipboard environment.

PHASE III: Build an engineering development model (this EDM may be classified or unclassified) automated self-defense application. Utilize the system to preset and launch self-defense weapons/countermeasures in a realistic at-sea engagement scenario demonstrating all aspects of the self-defense tactical decision aid system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This self-defense tactical decision aid can be applied with little additional modification to US Navy and allied surface ships of all classes. Automated self-defense systems capitalizing on the core architecture of a submarine system design can be used in similar ways on other military assets, as well as in foreign military sales.

REFERENCES:

1. http://www.uky.edu/BusinessEconomics/dssakba/bkpg1.htm

2. http://en.wikipedia.org/wiki/Knowledge-based_systems

KEYWORDS: submarine, self-defense, countermeasure, torpedoes, knowledge based systems, decision support

N093-193 TITLE: Shared Situation Awareness (SSA) Measurement

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

ACQUISITION PROGRAM: Undersea Warfare – Decision Support System (USW-DSS)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Innovative tool to measure human performance capacity in command and control, situational awareness and tactical decision-making scenarios.

DESCRIPTION: Cutting-edge technology is needed to present a way for naval decision makers to be removed from the "real world" about which they must make decisions that are intended to change a situation. Their mental models, which provide the basis for interpreting the systems representations of the situation, are constructed with information from decision support systems and their unique personal training/experience. The information provided by the systems to represent the actual situations is used by humans to build and maintain their mental assessment of the situation. The work of Endsley and her colleges has added substantially to our understanding of the ways in which human mental models of a situation are built, maintained and used to gain an understand the most salient elements of a situation for the purpose of decision making that are intended to have a desired change effect on it. Similarly, work done by Kline and his associates have increased our understanding of the "sense-making" cognitive activity required of humans to translate information about a condition into mental models that are reliable enough to use for making critical military decisions. Similarly, work in the development of ways to assess Situational Awareness (SA) such as the Real-time Communications, Situational Awareness and Cognitive Performance

Assessment System are increasing our capability to study SA concepts and issues that could help improve the utility of decision support technology. Another aspect in developing a SA measurement model, McGuinness states, is the differences of objective and subjective measurement, “which grossly differentiates between SA as revealed by objective queries (e.g., which target is highest priority?) and SA as revealed by subjective measures (e.g., rate your SA on a scale of 1-7). There can be real differences between what an operator "knows" (having assimilated or inferred the relevant items of information) and what he *thinks* he knows overall. ”An important aspect of maintaining SA is associated with the cognitive workload placed on humans who are required to build and maintain their personal mental models of the situation on which they will base the decisions and we are beginning to understand that cognitive workload is more determined by how often the decision makers must revise their models to accommodate new or ambiguous information or, if that becomes too demanding in time and effort, to simply ignore the new information. As noted by Nofi, for a group to develop a shared awareness requires three key elements, first building individual situational awareness, secondly, sharing individual awareness (which requires awareness of other’s actions), and finally developing a shared situational awareness or the overlapping of multiple individual models.

Currently, there is no capacity for defining and analyzing human cognitive workloads as it pertains to a thorough understanding of Situational Awareness and decision-making. As navy capabilities continue to improve and become increasingly more automated, the human cognitive process and response mechanisms will continue to be a necessary component in defining future navy needs. As such, the development of a measurement tool with objective metrics for improving situational awareness is needed that will benefit both training and the development of future command and control (C2) and decision support systems.

PHASE I: Conduct the needed R&D to identify and define the tools, standards and processes to support a system of Shared Situation Awareness (SSA) metrics and measures. Provide the analysis for a candidate approach and document the findings and recommendations.

PHASE II: Complete the additional R&D required to develop and demonstrate a prototype tool that will incorporate viable candidates to support Shared Situation Awareness (SSA) metrics and measurement. Provide the assessment of the total impact for the Navy’s improvement in decision support systems and training.

PHASE III: Integrate the Shared Situation Awareness (SSA) tool into requisite programs of record and decision support systems that require improvement in Situational Awareness.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovative ways to measure shared situational awareness can benefit commercial interests that require data strategies for collaborative decision making.

REFERENCES:

1. Albert A. Nofi, Defining and Measuring Shared Situational Awareness, CRM D0002895.A1/Final, November 2000 Center for Naval Analyses Alexandria, Virginia

2. Endsley, M. R., Bolte, B., & Jones, D. G. Designing for Situation Awareness: An approach to human-centered design. London: Taylor & Francis (2003)

3. Gary Klein, Brian Moon, Robert R. Hoffman, "Making Sense of Sensemaking 2: A Macrocognitive Model," IEEE Intelligent Systems, vol. 21, no. 5, pp. 88-92, Sep/Oct, 2006

4. Bolstad, Cheryl A., Foltz, Peter W., “Real-time Communications, Situational Awareness and Cognitive Performance Assessment System” Presentation to the DoD Human Factors Technical Advisory Group, November 3, 2008

5. Quantitative Analysis of Situational Awareness (QUASA) Barry McGuinness (Principal Scientist)(2004)

KEYWORDS: Network, Situational Awareness, Command and Control, Cognition, Meta-Cognition

N093-194 TITLE: Universal Atmospheric Contaminant Scrubber for Submersibles

TECHNOLOGY AREAS: Chemical/Bio Defense, Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: PMS399 SOF Undersea Mobility Program, Advanced SEAL Delivery System and DDS

OBJECTIVE: Although there are both single-use chemical based cannisters and recycling systems capable of removing CO_2 from atmospheres for much longer duration missions, nothing currently exists to remove VOCs at a high rate via a compact recycling system. This effort is focused on researching innovative methods to remove multiple classes of VOC compounds via one integrated system. The system must be capable of removing VOCs from a confined air volume rapidly, while minimizing the need to replace any consummable chemicals used. Furthermore, since the atmosphere is enclosed, the system cannot introduce any by-products back into the enclosed atmosphere that, while less harmful, still represent a health hazard to divers (e.g. CO_2). The only products the system may exhaust are O_2 and H_2O vapor. Ideally, the developed system will use chemical catalysts that do not require replacement, or some other innovative method, that will break down the hazardous chemicals into less harmful products, that will also be removed by the scrubber system. The system must also be lightweight and compact, requiring minimal power to operate, and minimal maintenance by field personnel. The system must meet safety requirements for use by people in a closed atmosphere by adhering to the requirements and guidelines defined within the System Certification Procedures and Criteria Manual of Deep Submergence Systems (NAVSEAINST SS800-AG-MAN-010/P-9290). The system should be compatible with the dimensional, power and weight constraints of both the ASDS and DDS.

DESCRIPTION: The Navy is seeking innovative solutions is to reduce the levels of both CO_2 and other VOC contaminants in manned compartments or within piping systems aboard deep submergence systems. Although many commercially available methods to remove CO_2 exist, none of these methods currently remove both CO_2 and other VOC contaminants from the atmosphere simultaneously, in one system. These confined spaces are primarily susceptible to accumulating high levels of CO_2, but occupants may potentially be exposed to a wide range of other contaminant gasses. Gasses to be removed from the atmosphere by the system are, in order of importance: Carbon Dioxide, Carbon Monoxide, Ammonia, Hydrogen, Sulfur Dioxide, Hydrogen Sulfide, Benzene, Chlorine, Mercury vapor, Trichloroethane and other gasses (as listed in Appendix F of NAVSEAINST SS800-AG-MAN-010/P-9290). In addition, the system should be capable of reducing contaminants sourced from non-metallics and materials used in the manufacturing, maintenance and cleaning of DSS (i.e. curing paints, adhesives, resins and solvents). The designed system shall be fully compatible with a 28V DC power supply. The designed system shall be sized as necessary (or scalable to different sizes) to ‘scrub’ a manned space as small as 180 cubic feet (with 6 people) to one as large as 1700 cubic feet (with 10 people) for a duration of up to 10 hours without requiring any maintenance or replacement of chemicals. The system shall be able to reduce the concentration of the target gasses in the atmosphere by a factor of ½ in a maximum of five minutes. The designed system shall be capable of withstanding operating and non-operating conditions where temperatures and pressures vary from 1 to 6 atmospheres and 29 to 140 degrees Fahrenheit Any materials used within the system must remain effective across this temperature and pressure range, and shall not themselves off-gas any harmful gasses or pose any additional risks to personnel. The proposed solution and its integration into the DSS at baseline operation and maximum operating conditions will be verified, as well as its ability to remove CO_2 and other containments to the threshold levels identified in Tables 3 and 4 of Appendix F.

PHASE I: Research potential chemical or other methods to remove all the VOC gasses listed from an enclosed atmosphere, without introducing any other by-products back into the atmosphere, and without requiring overboard discharge of any by-products. Develop laboratory-scale test beds and conduct testing to determine the validity of each approach by demonstrating appreciable reduction of CO_2 and other contaminants (Obtain approval from the TPOC for testing methods and criteria). Using these results, determine which approach is most effective, and can be scaled up to work in a full-scale system. Demonstrate through engineering analysis the ability of such a full-scale system to remove CO_2 and other contaminants from up to 1700 cubic feet of enclosed volume within the limits described above.

PHASE II: Design and incorporate best scrubbing method(s) identified during Phase I into a prototype. Perform testing in a realistic environment by simulating a submersible environment. Use the test results to select the optimum system configuration and settings. Perform suitability, performance and reliability analysis of the prototype system. Develop an Engineering Development Model that is representative of the expected final commercial design, and capable of being tested (real-world testing will occur during a Phase III follow-on transition period) to ensure final system design will meet shock, vibration, and Scope of Certification requirements for unrestricted Navy Deep Submergence System operations. Phase II Option: Develop installation drawings, required Objective Quality Evidence, (as defined in NAVSEAINST SS800-AG-MAN-010/P-9290 under Material Control Divisions) and commercialization, and transition plans for full-scale shipboard implementation.

PHASE III: Provide EDM and vendor support for real-world operational test and evaluation of the system, finalizing the final packaging, user interface, etc. and qualifying the system to allow it to be installed as a Temporary Modification onboard a US Navy Submersible. Develop technical and user manuals, end-user training programs, logistics/ repair support plans, and troubleshooting and repair guides. Conduct initial end-user training and operator certification. Field the validated system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The selected CO2 and contaminant scrubber system could find use in other Navy combat submersibles or private submersibles (tourist submersibles, oil rig submersibles, exploration submersibles such as ALVIN, etc.). It may find use in any application where exposure to harmful gases is possible such as waste facilities, workers in confined thanks or coal mines or certain factories.

REFERENCES:
1. System Certification Procedures and Criteria Manual for Deep Submergence Systems (SS800-AG-MAN-010/P-9290)

KEYWORDS: Submersible; underwater; atmospheric, contaminants, carbon-dioxide, removal

N093-195 TITLE: Long Life Energy Storage Systems for Shipboard Sensor Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: ACAT I. VIRGINIA Class Submarine, NAVSEA PMS450.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a long endurance, low power output, low cost battery or other energy storage system to provide power for wireless sensors in a shipboard environment.

DESCRIPTION: Wireless technology is being integrated into shipboard sensor systems to significantly reduce installation cost. The application of wireless technology, however, is currently limited to those sensor systems with low data rate and low duty cycle requirements. The power demands of high data rate and high duty cycle sensor systems will quickly deplete the power in currently available batteries. A concept of combining a energy harvesting system with an efficient energy storage system is being explored to support the duty cycle demands of a shipboard condition based monitoring system. This solicitation seeks innovative battery or other energy storage system technology that will allow high data rate and high duty cycle wireless sensor systems for shipboard applications to become feasible.

The guidelines for the battery or energy storage system are:
- Voltage: 2 - 5 Volts
- Maximum instantaneous output power: 3 watts

- Nominal output power: 100 miliwatts
- Capacity at nominal output: 500+ Watt-Hours (Note that this is 3 times the current state of the art)
- Size: 2 D cells or smaller
- Rechargeable – maximum input power 1 watt
- Must meet requirements for shipboard use (e.g. operate in a rugged environment)

PHASE I: Determine the feasibility of developing a rechargeable long endurance, low power output, low cost battery or other energy storage system. Perform design and analysis of long endurance, low power output, low cost battery or other energy storage system, and define its performance characteristics, develop a design configuration, safety and environmental parameters, and select the major components for proving the feasibility of the proposed system. Analyze all possible failure mechanisms and estimate battery or other energy storage system reliability, based on the performance of the electrical and mechanical subsystems.

PHASE II: Design and develop a full-scale prototype battery or other energy storage system ready for installation into a wireless sensor system and conduct laboratory and shipboard demonstrations.

PHASE III: Design and fabricate production prototypes for installation into a wireless sensor system for full-scale at-sea testing and transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Development and production of a long endurance, low power output, low cost battery or other energy storage system can be used by the private sector to make a number of potential commercial wireless sensor systems feasible.

REFERENCES:
1. Sol–gel template synthesis of LiV3O8 nanowires, Journal Journal of Materials Science, Publisher Springer Netherlands, ISSN 0022-2461 (Print) 1573-4803 (Online) Issue Volume 42, Number 3 / February, 2007, DOI 10.1007/s10853-006-0022-y, Pages 867-871, Subject Collection Chemistry and Materials Science SpringerLink, Date Wednesday, January 10, 2007.

2. The Charge of the Ultra-Capacitors by Joel Schindall, IEEE Spectrum Online http://www.spectrum.ieee.org/nov07/5636, November 2007.

KEYWORDS: battery; shipboard; wireless; energy; storage; sensor

N093-196 TITLE: Secure Open Architecture Open System Technologies for Tactical Networks

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Submarine Combat and Weapons Control Program Office (PMS425) - ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a technology that will segregate data of various security classifications without affecting the system's open architecture design or open system standard compliance.

DESCRIPTION: Technologies for data system security, in particular the NSA High Assurance Platform (HAP), have demonstrated promising results in their ability to securely process, protect and segregate multiple levels of classified and/or sensitive data. These technologies, however, have yet to be applied to submarine tactical environments due to the technical risks inherent with addressing key performance, stability functional, and Navy Open Architecture requirements. This topic will focus on bridging the gap that exists between current state-of-the-art high assurance technology capabilities and the performance, stability, and functional requirements for current and future tactical systems. Efforts will focus on developing technologies that extend beyond or are outside the scope of the NSA HAP. Developing a technology that is robust enough to maintain an open architecture standard while handling sensitive data in a tactical environment will offer great potential to expand the capability of systems while reducing the costs to develop, implement and maintain them.

PHASE I: Develop a system design based on the High Assurance Platform Workstation (HAPWS) design for a secure tactical system that does not compromise Navy Open Architecture Standards. The system design should replicate the capabilities, functions and performance characteristics of an actual tactical system.

PHASE II: Design and test required prototype hardware and/or software solutions proposed in Phase I on a simulated shipboard network (e.g., in a Navy lab environment). Provide Government with all prototype, design, and software products (to include source code) for Government use only.

PHASE III: Install and test the Government approved system on board one or more designated Navy submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This effort has direct applicability to numerous environments where classified or sensitive data is processed. Commercial sectors such as financial services, health care, and critical infrastructure could greatly benefit from the extension of open architecture technology to systems that perform mission critical or real-time processing.

REFERENCES:
1. Department of Defense Instruction 8500.2, “Information Assurance (IA) Implementation,” 6 February 2003.

KEYWORDS: Tactical Information Assurance; Navy Open Architecture Standards; Navy Security Requirements; sensitive data segregation; data classification segregation

N093-197 TITLE: Improved Safety in Large Format Lithium-Ion Cells and Batteries

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: PMS399 Special Operations Forces Undersea Mobility Program Office - ASDS

OBJECTIVE: To develop large format lithium-ion cells and batteries that can provide total capacities in excess of 1 Mega-watthour (MWh) while demonstrating improved safety characteristics that reduce the effects of cell failures, eliminate the propagation of cell failures, and thereby reduce the system impact of failure to levels acceptable for use on Navy underwater platforms.

DESCRIPTION: Lithium-Ion systems are more volumetric and gravimetrically efficient than other rechargeable battery systems that can provide cycle life in excess of 200 cycles and 5 years wet life. Unfortunately, energetic failure of a cell normally results in damage to adjacent cells, to battery hardware and to platforms, which can propagate throughout the system. The impact and severity of failure propagation increases with the size of the battery, with a corresponding increase in the likelihood and severity of collateral damage to peripheral assets.

Although there has been previous work done in methods to improve the safety of small scale Li-Ion batteries, these solutions do not work when scaled up to the sizes and capacities needed to provide primary power for a combatant submersible. This topic seeks innovative methods to improve the inherrent safety of very large scale Li-Ion batteries.

This solicitation seeks innovative improvements in battery and cell technologies that can be incorporated into large-scale Lithium-Ion battery and cell technologies (e.g. possible alternate electrode, electrolyte, or cell component materials) which reduce the energetics of a catastrophic cell failure, and make the cell robust against thermal runaway and against thermal abuse in such a manner as to prevent propagation. These safety modifications must be able to be made while still maintaining cell-level specific energy in the range of 150 to 200 Wh/kg and cell energy density in the range of 300 to 400 Wh/l. The offeror shall target cell sizes ranging from 100 Ah to 500Ah or larger, with cycle life targets in excess of 200 cycles over 5 years.

This solicitation also seeks innovative assembly-level and system-level approaches which reduce the energetics and impact of a catastrophic cell failure and prevent the propagation of a cell failure. Approaches can include mechanical, chemical, thermal methods or otherwise, but should be applicable and effective in addressing the unique needs of high voltage (300 V) and high capacity systems (in excess of 1 MWh), while maintaining system-level specific energy in the range of 140 to 160 Wh/kg and system-level energy density in the range of 250 to 350 Wh/l. Assembly-level and system-level approaches should also consider the need in many situations to break high capacity systems into multiple modular units (e.g. 50 to 100 kWh) which are installed inside pressure vessels for underwater use.

PHASE I: Perform basic R&D to further develop battery and cell technology for safe very large scale Li-ion batteries. Conduct a feasibility demonstration of proposed innovative new material or design concepts, that limit the energetics of lithium-ion cell failure and prevent failure propagation, in a laboratory environment. Demonstrate by engineering analysis that the materials and design concepts are scalable, and will improve the safety of large scale Li-Ion battery applications in high voltage (300 V) and high capacity systems (in excess of 1 MWh), without sacrificing performance significantly. Analyze these designs based on factors listed above, including reliability, efficiency, weight, EMI considerations, size, and predicted cycle life, in addition to the inherent safety of the battery system itself.

PHASE II: Implement and verify the design and concepts from Phase I in full-size cells and full-scale multi-cell modules. Develop prototype battery management system to safely regulate the cells during charge and discharge evolutions. Build prototypes, and conduct proof-of-concept testing in a laboratory environment. This testing should include long term cycle testing and safety testing per reference 1 to assess the safety and performance of the new design. Validate efficiency and energy and power density storage of prototype systems. Develop final Engineering Development Models (EDMs) capable of being installed shipboard. Vendors shall submit a business plan for the commercialization of the technology developed under this topic. The Small Business Administration's web site www.sba.gov provides guidance, examples, and contact information for assistance.

PHASE III: Conduct shipboard testing and suitability analysis of the EDM systems, including shock, vibration, and Scope of Certification testing for Navy Deep Submergence System use. Validate safety and efficiency of EDM system in a true at-sea environment. Develop commercialization, and transition plans for full-scale shipboard implementation. Develop technical and user manuals, end-user training programs, logistics/ repair support plans, and troubleshooting and repair guides. Conduct initial end-user training and operator certification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The safety of lithium batteries has long been a concern and use of the technology is limited because of the safety features. If this program is successful more platforms and commercial sectors, including the hybrid and electric car industry, airline industry, and space industry could realize the benefits of the technology.

REFERENCES:
1. NAVSEAINST 9310.1B, Naval Lithium Battery Safety Program

KEYWORDS: lithium-ion; failure; propagation; safety; prevention; mitigation

N093-198 TITLE: Sonar Detection / Classification Based on Material Identification

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: NAVSEA, PEO-SUB, PMS 404, Torpedo development. Mr. Michael Michaels

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Define an acoustic concept / algorithm that will enable the identification of the material composition of a detected underwater contact to enhance active sonar systems performance. The proposed concept must identify the phenomena(s) given rise to the material identification clues as well as the waveform design and related signal processing.

DESCRIPTION: The key ingredient to any sonar detection / classification capabilities is the ability to identify the target of interest and eliminating false targets generated by bottom clutter. This ability becomes much more difficult in shallow waters where the clutter provides larger number of false detections / target like contacts. The fundamental problem can be attributed to the fact that generally sonar's exploit the specular and diffractive scattering from objects which are similar in the active acoustic response from targets and false targets. The novelty of this proposed effort is that it focuses on exploiting the material composition of objects which differ drastically between targets and false targets. If successful this concept would have a major impact in minimizing false targets and correctly identify target (s) of interest.

The U.S. Air Force has developed algorithms for radar for the automatic determination or discrimination, in a setting of intense clutter, of both inorganic and organic materials. The motivation for this SBIR is to see if a similar capability could be achieved in an underwater acoustic environment.

PHASE I: Conduct the R&D needed to mathematically formulate a concept to identify material composition of objects using active sonar. The concept must identify the physics given rise to the clues that will be exploited to identify the material. Additionally the concept must address any unique waveform design and related signal processing.

PHASE II: Complete the R&D to fully support the solution. Then develop algorithms (both Physics and Math modeling based) for material identification in conjunction with conducting acoustic tank sonar experiments to demonstrate the applicability and performance of the new technique for detection and classification for active sonar systems.

PHASE III: Demonstrate impact on existing system performance using advanced Navy hardware in the loop simulators. Transition algorithm to advanced sonar and weapon systems developers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Underwater exploration is critical to the survival of mankind. Its importance extends from environmental protection and monitoring to finding mineral deposits or sunken objects. The proper identification of sunken objects / clutter in ports is critical to cleaning the environment and / or introducing new underwater hardware. A robust sonar based material recognition capability would make underwater exploration and exploitation more efficient and cost effective.

REFERENCES:
1. Broadband Low Frequency Sonar for Non-Imaging Based Identification, B. H. Houston, J.A. Bucaro, T. Yoder, L. Kraus, and J. Tressler (Naval Research Laboratory), J. Fernandez (Coastal Systems Station, Panama City Florida) T. Montgomery (Applied Research Laboratory - Pennsylvania State University), T. Howarth (NUWC, Newport), IEEE Oceans Engineering 2002, 383-387

2. NEW GREEN FUNCTIONS FOR NEARFIELD ACOUSTICAL HOLOGRAPHY IN AIRCRAFT FUSELAGES, Eaxl G. Williams & Brian H. Houston (Naval Research Laboratory), American Institute of Aeronautics and Astronautics, 1996

3. H. Liu, P. Runkle, L. Carin, T. Yoder, T. Giddings, L. Couchman, and J. Bucaro Classification of distant targets situated near channel bottoms J. Acous. Soc. Am. 115(3), March 2004

4. P. Runkle, L. Carin, L. Couchman, T. Yoder, and J. Bucaro, "Multi-aspect Identification of Submerged Elastic Targets via Wave-based Matching Pursuits and Hidden Markov Models," J. Acous. Soc. Am., vol. 106, pp. 605-616, Aug. 1999

KEYWORDS: Sonar detection / classification, Elastic acoustic response, Underwater Material identification; Acoustic Echoes;

N093-199 TITLE: Increased Submarine RF Capacity for Sensors and Surveillance

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMS-450: VIRGINIA Class submarine: ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop technologies for radio frequency distribution (RFD) and processing over fiber optics that provide substantial reduction of signal loss, electromagnetic interference, and reduced Size, Weight, and Power (SWaP).to be used in submarine communications and surveillance systems.

DESCRIPTION: The potential for innovative development of RF distribution and processing of data over fiber vice copper coax or waveguide on submarines offers two notable benefits. The first benefit is substantial reduction of Size, Weight and Power (SWaP) requirements. The Navy is interested in reducing submarine RFD volume requirements by 50%. Such reduction will permit inboard and outboard consolidation of the volume, such as sensor masts, needed to containing communication/sensor equipment and will also allow for increased surveillance capability. The current RF path through multiple connectors results in high data losses. At the same time, the performance of current commercial RF over fiber technologies can be limited because of the short link distances in military platforms such as submarines (4). The length of a VIRGINIA Class submarine is 377 feet; its beam is 34 feet. Innovations in RF photonics transport technologies would improve the signal to noise ratio. Also, current commercial solutions are insufficient to meet Navy surveillance requirements. High dynamic range over a wide bandwidth from VHF to EHF is required, and distribution of signals from outboard sensors to inboard processing while minimizing losses is required.

Cabling, waveguide, RF connectors and associated electronics all offer substantial SWaP reduction opportunities. The VIRGINIA Class submarine provides transition opportunities in the nearer term. Innovations in this area, moreover, will significantly influence future design decisions for the Sea Based Strategic Deterrent (SBSD) (Ohio Class replacement submarine program) Responders should focus on a point to point implementation of a sensor, RFD, and receiver as a Phase I proof of concept. Phase II will provide the opportunity for implementation of a more specific application. While the focus of this topic is on the submarine, the technology development has applications to other Navy platforms.

PHASE I: For the particular submarine application selected, determine the feasibility of a design that supports the requirements and recaptures significant volume. Demonstrate the feasibility using analysis and/or laboratory demonstration.

PHASE II: Complete the detailed research and development required to design and fabricate a prototype based upon the Phase I concept. The prototype should include sensor (or emulator), RFD, and receiver. Demonstrate with the prototype that key system performance specifications are met within reduced volume.

PHASE III: Incorporate the prototype design into a Navy Intelligence, Surveillance and Reconnaissance (ISR) program

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovations in the area of RF distribution will benefit the telecommunication industry and airline industries.

REFERENCES:
1. Ehmke, J.; Brank, J.; Malczewski, A.; Pillans, B.; Eshelman, S.; Yao, J.; Goldsmith, C.; “RF MEMS devices: a brave new world for RF technology”, Proceedings of the 2000 IEEE Emerging Technologies Symposium

2. Pozar, D. Microwave Engineering, Wiley, 2004

3. Pappert, Steve, Use of RF Photonics in Next Generation Military Antenna Systems. December 6, 2000. http://www.darpa.mil/mto/programs/aosp/pdf/pappert.pdf

4. Jacobs, E.W.; Rodgers, J.S.; Evans, D.C.; Weiner, T.E.; Lin, C., Considerations for Application of RF-over-Fiber to Navy Systems. Avionics, Fiber-Optics and Photonics Technology Conference, 2007 IEEE, Volume, Issue, 2-5 Oct. 2007 Page(s): 3 – 4. Abstract and ordering information at http://ieeexplore.ieee.org/Xplore/login.jsp?url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F4365709%2F4365710%2F04365719.pdf%3Farnumber%3D4365719&authDecision=-203
(Other references to related articles by the authors of (3) and (4) can be found through websites such as Google Scholar.)

5. Ships, Sensors, and Weapons. Undersea Warfare Programs Target an Expeditionary Future. http://www.subsim.com/ssr/page46.htm

KEYWORDS: electronic warfare, communications, radio frequency distribution, photonics, RF over fiber, intelligence surveillance and reconnaissance (ISR), sensors

N093-200 TITLE: Higher Temperature Passive Components, Integrated Circuit Elements for Transmit/ Receive (T/R) Modules

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: NON-ACAT X-Band and S-Band Radars and EW Arrays

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop thermally and environmentally robust passive components, integrated circuit elements that can operate without significant life degradation in the proximity of hot high power Wide Band Gap (WBG) amplifiers.

DESCRIPTION: WBG power amplifiers currently being designed into many emerging radar and EW electronically steered arrays have higher power dissipations and the resultant T/R modules have locally elevated temperature in the areas adjacent to the power devices. Passive circuit elements that support these hot components are required to be robust and capable of operating at elevated temperature levels without significant life degradation. This topic seeks to identify and develop thermally and environmentally robust passive components/integrated circuit elements that can operate in the proximity of high power WBG devices without life degradation. Metric for the passive/circuit element to be developed will be that it provides equivalent or improved electrical performance over its existing state of the Art Transmit/Receive(T/R) module equivalent while providing improved temperature robustness and/or size reduction (see references). These passives and circuit elements must also operate reliably over a Navy shipboard Phased Array Radar and EW Electronically Steered Arrays (ESAs) systems anticipated 20 year service life.

Passives/ integrated circuit elements of interest include:
- Higher temperature passives for MMICs
- Smaller inductors
- Improved (smaller, broader bandwidth, higher power handling) isolators for T/R modules

- Improved (smaller, lower noise figure, higher power handling) limiters for T/R modules

PHASE I: Perform the R&D needed to support the design and modeling process, and then conduct analyses of thermally and environmentally robust passive components, and integrated circuit elements meeting the intent of this topic.

PHASE II: Complete detailed R&D required to develop the manufacturing processes and build prototype test modules with the passive components, integrated circuit elements selected from Phase I. Evaluate stable MMIC/ T/R module electrical performance over anticipated operational temperature ranges and meet or exceed this topics stated objectives. Validate the new manufacturing processes and test developed hardware performance of the passive components, integrated circuit elements and/or interconnections. The technology must demonstrate that it can satisfactorily function in a T/R module assembly intended to be used in a Navy shipboard Phased Array Radar and EW system. In addition, conduct preliminary cost modeling to show that the technology is cost competitive with current State of the Art T/R module production processes.

PHASE III: Establish manufacturing processes and quality controls to provide production quality passive components, integrated circuit elements integrated into T/R modules of interest to IWS Radar and EW applications. Manufacture T/R modules to demonstrate final processes and conduct electrical and environmental performance testing of the contractor's technology. Conduct cost modeling to show that the developed technology is cost competitive with current State of the Art T/R module production processes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Elevated Temperature passive components, integrated circuit elements will have applications in many commercial industries as well as on numerous military systems.

REFERENCES:
1. "GaAs MMIC Reliability Assurance Guideline for Space Applications", S. Kayali, G. Ponchak, R.Shaw, JPL Publication 96-25.

2. Bahl, I., and P. Bhartia, Microwave Solid State Circuit Design, John Wiley & Sons, Inc., New York, 1988.

3. Electronic Materials Handbook, Volume 1 Packaging,ASM International.

KEYWORDS: passive components; integrated circuit elements; T/R Module ; Radar ; EW ; Phased Array

N093-201 TITLE: <u>Band Limited Pulse Encoding and Signal Classification</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Weapons

ACQUISITION PROGRAM: PMS404 ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Development of innovative approaches for band-limited undersea pulse encoding and echo signal classification.

DESCRIPTION: Undersea weapons typically employ active sonar for target localization. In active sonar, a high-energy pulse is transmitted into the ocean medium, the pulse travels to and bounces off of targets and clutter (ocean surface and bottom, schools of fish, etc.), and the echo is later received by the underwater weapon. Round-trip signal travel time provides an estimate of target range and arrays of sensors on the weapon provide an estimate of target direction. Decoys may intercept these transmitted signals, estimate their characteristics (frequency, pulse shape, etc.) and create a fake echo which may fool the weapon into prosecuting this false echo in lieu of a true target. This SBIR topic seeks innovative schemes for pulse coding which might enable undersea weapons to better classify false echoes as false echoes.

Typical RADAR systems may employ very wide-bandwidth (spread-spectrum) techniques for pulse encoding, or wide-bandwidth phase encoding (pseudo-random noise (PRN) signals) however, these bandwidths are not well-supported by the ocean medium and typical sonar hardware. Sonar system bandwidths of approximately one to two octaves in the near-audio regime are typical in many applications (15-60 kiloHertz). The challenge is to develop effective pulse encoding technologies utilizing this limited spectral band.

Of course, as sonar systems mature, so do decoys. False echo generation systems may employ sophisticated Digital Radio Frequency Memory (DRFM) to accurately capture copies of incoming signals for subsequent re-transmission, and may also amplify and Doppler shift these false echoes to produce convincing, loud false echoes from an apparently fast-moving target that may confound a sonar's ability to locate a comparatively weak echo from a true target.

PHASE I: Development of candidate approaches for effective signal coding and signal classification using a given representative set of transmitter and receiver capabilities (sound pressure level, receive sensitivity, radiation and reception patterns, spectral bandwidth, amplitude envelope control, phase control, pulse duration, etc.). Conduct research and development (R&D) to develop potential innovative analytical theories and approaches. These investigations should identify the strengths (such as relative performance benefits) and weaknesses (such as implementation challenges) of candidate approaches and also identify the preferred approach(es) for Phase II.

PHASE II: Further develop the most promising innovative approaches identified in Phase I to demonstrate, using simulations and in-water data, where available, prototype algorithms for effective signal coding and echo classification (candidate methods may be simulated and evaluated using common programming languages (C, C++) and analysis tools (Matlab®)). Develop measures of effectiveness (MOE) to be evaluated in Phase III and identify any Government-supplied hardware required for Phase III demonstration. Participate in the spiral development process for undersea weapons (a phased process for concept development and evaluation).

PHASE III: Develop test plans and demonstrate the effectiveness of the pulse coding and signal classification approach(es) in an undersea environment using representative weapon hardware (transmitter, sensor, receiver) and undersea echo repeaters. Analyze in-water data and compare performance with existing approaches. Continue to participate in the spiral development process for undersea weapons.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Sonar signal classification technologies to better discriminate true sonar contacts from intentionally created false echoes. These technologies might be used for a Port Security applications where large numbers of false decoys may be created to mask a true interloper.

REFERENCES:
1. Goj, Walter W., “Synthetic Aperture RADAR and Electronic Warfare,” Artech House, Boston, 1993.

2. Vakin, Sergei A., et. al. “Fundamentals of Electronic Warfare,” Artech House, Boston, 2001.

3. Adamy, David A., “EW 101,” Artech House, Boston, 2001.

4. Waite, A D, “SONAR for Practising [sic] Engineers,” John Wiley & Sons Ltd., 2002.

5. Roome, S. "Digital Radio Frequency Memory," IEE Electronics and Communications Engineering Journal, (August 1990), pp. 147-53.

6. DeFilippo, et al., "Simulator for advaced fighter EPM development," IEE Proc. Radar Radar, Sonar and Navigation, vol. 148, no 3, (June 2001), pp. 139-46.

KEYWORDS: signal processing; classification; waveforms; encryption; undersea weapons; countermeasures

N093-202 TITLE: Innovative Damping Technologies

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: VIRGINIA Class, NAVSEA PMS450. ACAT I

OBJECTIVE: This topic seeks to identify and demonstrate marine composite structural configurations that provide the best balance between weight, structural performance and noise and vibration control.

DESCRIPTION: Many structures are subjected to high levels of vibratory energy as a result of being in the transmission path via direct contact or due to acoustic excitation from air-borne noise sources or rotating machinery. Vibration amplitudes of laminated composite panels subjected to random and sinusoidal excitations can be shown to be functions of the mass, damping, frequency and stiffness of the structure. For a laminated composite structure, each of these properties can be determined from constituent material properties and a definition of the material architecture. Hence, it is theoretically possible to tailor the properties of a composite structure to minimize direct and acoustically induced vibration levels. Innovative approaches for reducing noise induced vibrations, with minimal cost and weight impact are desired.

PHASE I: Conduct the R&D required to physically understand the individual and coupled dynamic response of the family of composites deemed relevant to the navy environment. Develop concepts for highly damped materials and demonstrate the feasibility of the concept with respect to its use in the marine composite environment via analyses and/or tests. In addition to structural performance, address its manufacturability, and durability aspects in the Phase I option.

PHASE II: Develop and demonstrate the performance capabilities of the concept at the component level (i.e. a sandwich or stiffened panel or other structurally relevant configuration) Demonstrate examples of manufacturability and durability of the system through testing.

PHASE III: Insert the product into a candidate marine application and test as part of other technology demonstrator activities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The damping technology could be applied to any sea, land or air vehicle where load induced excessive vibrations can initiate premature failures or introduce passenger discomfort.

REFERENCES:
1. Unger, E. E., “Damping of Panels”, Noise and Vibration Control, Ch 14, McGraw-Hill, 1971, pp. 434-475.

2. Nashif, Joes and Henderson, “Surface Damping Treatment”, Vibration Damping, Wiley & Sons, 1985, pp. 258-362

KEYWORDS: Composites, GRP, advanced fibers, damping, loss factor, constrained layer

N093-203 TITLE: Implosion-Proof SOF Mission Equipment Storage Container

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS399 Special Operations Force Undersea Mobility/PEO Naval Special Warfare

OBJECTIVE: Research the most common failure modes of small implodable volumes collapsing (i.e. determine characteristics of the resultant shock wave, determine what hazards this shock wave represents to divers, etc.), then develop a man portable container that protects divers from multiple hazards related to equipment being carried, including harmful off-gassing and flammability of contents under pressure, and implosion or explosion of small sealed volumes due to pressure changes.

DESCRIPTION: Special Operations Forces divers routinely carry equipment to and from missions. These components may or may not be designed for exposure to high or rapidly changing pressures. In pressurized environments, many items that pose no safety risk at one atmosphere may start to off-gas harmful or flammable gases, and may collapse rapidly if there is a sealed, uncompensated volume of air present within the component. It is often not possible to fully assess these risks for every piece of equipment that is carried on board during SOF missions. Additionally, many of these items are electronics that must be protected from seawater, so any container must be waterproof as well.

Currently, the SOF community has a waterproof container (a bag) that also contains any potential harmful gases that may be produced by equipment under pressure, but this bag does not provide any protection to the divers from an item imploding or exploding within the bag. It also provides no protection in the event items within the bag ignite.

The innovation desired in this effort relates primarily to developing new materials or designs for mission support equipment containers capable of containing the pressure wave generated by small volumes suddenly imploding or exploding due to pressure changes. The shock wave of these items must be attenuated or contained such that nearby divers are not harmed by the implosion or explosion event.

For this SBIR effort, the SOF community is seeking an innovative new design for a man-portable container that will store 1.5 cubic feet of mission support equipment, most items similar in size to hand held radios, night vision equipment, etc. The container must be able to protect against several items with sealed implodable volumes up to 200 cubic inches collapsing simultaneously. The container must also be able to contain any off-gassing of the contents, and contain any fires that may result from small Li-Ion batteries or other components becoming flammable under pressure in the container. The container must also be adjustable in order to achieve a neutral buoyancy while fully loaded and submerged. If a container of this size is successfully developed and tested, then other standard and potentially custom sized containers will likely be sought during a Phase III follow-on procurement.

PHASE I: Perform R&D required to develop a reasonable model for how small implodable volumes collapse, and the resulting shock wave. Determine the potential hazard to divers this shock wave represents. Based on this model, conduct a feasibility study of several alternative approaches and potential designs for a mission equipment storage container that meets all of the requirements listed above. Demonstrate through engineering analysis the ability of the potential designs to contain or attenuate shock waves resulting from implosions or explosions within the bag. Provide a detailed report on the strengths and weaknesses of each potential design.

PHASE II: Design and develop a prototype storage system based on this best design evaluated during Phase I. Demonstrate in a laboratory environment the ability of the bag to:
1) Contain implosions and explosions and any resulting fragmentation and shock waves of at least two items up to 200 cubic inches in implodable volume.
2) Contain or extinguish small fires started within the container, and
3) Contain any Volatile Organic Compounds (VOCs) generated by equipment in the bag under pressure.
Develop one Engineering Development Model that can be delivered to the Special Operations Community for testing and evaluation in a real-world environment.

PHASE III: Develop all necessary operators manuals, preventive maintenance instructions, or other documentation necessary for Navy personnel to maintain the equipment. Obtain a National Stock Number and ensure resulting commercial product is made available within the Navy Supply System for ordering.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will be applicable to both military and commercial divers to protect them from harm resulting from equipment they must carry with them. The off-shore oil industry and underwater hull husbandry markets will directly benefit. This technology would also be useful to the space and aerospace industries, as it can contain fires, toxic gases, and explosions due to decompression of items within the container.

REFERENCES:
1. NAVSEA SS800-AG-MAN-010/P-9290, System Certification Procedures and Criteria for Deep Submergence Systems

KEYWORDS: equipment; bag; implosion; explosion; waterproof; fireproof

N093-204 TITLE: Synthetic Elements for Moving Line Arrays

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS401 (TB-16 submarine towed array)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: To develop a methodology for exploiting towed array motion to process higher frequency regions at all steered directions in order to use the full frequency capability of a towed array.

DESCRIPTION: Beamformed line arrays are limited in frequency coverage by both the Nyquist rate imposed by temporal sampling and by the spatial separation of the individual elements of the array. The spatial limitation, analogous to the Nyquist rate, is imposed by the necessity of adequately sampling the waveform in space in order to distinguish one arrival angle from another. A moving line array effectively samples the space more densely than a stationary array, and, thus, with an adequate temporal sampling rate, meets the sampling criterion for higher frequency coverage than does the stationary array.

Existing work in the closely related area of passive synthetic aperture sonar (SAS) seeks to use array motion to extend the effective aperture, subject to the constraint of signal coherence in time and space, to provide improved estimation of arrival angle. This topic focuses on providing additional frequency coverage by increasing the effective array population with “synthetic elements".

Signal processing’s most common constraint is, perhaps, the Nyquist criterion, limiting frequency coverage based on the time sampling rate. The cost of violating this temporal constraint is aliasing – signals of one frequency appearing at another, incorrect frequency. Arrays sample spatially by using an arrangement of discrete elements. In array beamforming, the analogous frequency constraint due to spatial sampling depends on the separation of the elements versus the wavelength of the signal in the medium. Processing above the spatial design frequency incurs the penalty of grating lobes – aliasing of a signal on one beam to other beams, possibly obscuring other signals. The grating lobes that result depend on the location in azimuth of the source, as well as the frequency of the signal and are completely predictable.

In a stationary array, there is no remedy for the grating lobes because there is no additional information to be exploited. In the case of moving arrays, however, additional spatial sampling results from the array’s motion. In particular, synthetic elements can be created using a combination of time delay and phase shifting.

The phase shifts depend on the source frequency, not the bin frequency or the observed frequency. The observed frequency will be a function of the relative motion between the array element and the source, but the phase shift required to remove the effect of the imposed time delay is a function of the change in phase of the field at a static location.

PHASE I: Perform the R&D to develop an approach to increase the useful frequency coverage of beamformed line array data and mitigate the effects of missing array elements to improve beamformer performance in a degraded array.

PHASE II: Expand the development to an actual real data set. Demonstrate the implementation of these concepts with test data involving a moving line array relative to far-field static sources from a range of azimuths and demonstrates the mitigation of grating lobes. Report the results with needed algorithm refinement and repeat demonstrations.

PHASE III: Transition algorithms developed in Phase II to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The work developed here should be applicable to all moving array receivers in all fields.

REFERENCES:
1. M. H. Johnson, "Synthetic elements for the towed array" (IAR project). https://donst.nrl.navy.mil/cgi-bin/login-form.cgi

KEYWORDS: towed array; synthetic aperture; beamforming; grating lobes; sampling; Nyquist

N093-205 TITLE: <u>Non-contact sea water optical attenuation meter</u>

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: AN/AES-1 (ALMDS), ACAT-II; AN/AWS-2 (RAMICS), ACAT-II; also LCS Mission Mo

OBJECTIVE: To develop a laser-based sensor for determining the optical attenuation ("k") of sea water which can be operated from shipboard by a sailor with minimal oceanographic training to determine the environmental suitability of local waters for the operation of various electro-optical systems, such as AN/AES-1 (ALMDS), and AN/AWS-2 (RAMICS)

DESCRIPTION: The device which this SBIR asks to be developed is a unique sensor which can determine the optical attenuation of sea water without the necessity of inserting anything in the water. What is desired is a sensor which uses a laser to illuminate the water, and a receiver assembly which receives the light, and determines the rate at which the intensity of the light varies with depth/range in water. The attenuation so measured will, in turn, allow the Mine Warfare Environmental Decision Aids Library (MEDAL) to prepare the most suitable mission plans to maximize the utility of ALMDS or RAMICS. This value can then be compared with the performance characteristics of the various sensor systems to determine their suitability for use in the local water optical conditions where the measurement is made, and to establish the operational/employment plans to optimize ALMDS performance in the existing environment. This device will be capable of making single-point measurements at the location in which it is employed, but this will normally be close enough to the environment at the MCM operating area for mission planning. Although such measurements have been made on a through-the-sensor basis with other electro-optic sensor systems (e.g. Magic Lantern), to date no such device has been developed which operates in an independent fashion such as is envisioned here. In order for the device to operate, R&D will need to be performed to develo theoretical solutions that can be utilized to develop data analysis software to analyze the acquired data and convert that data into a determination of the optical attenuation. The device envisioned for development under this SBIR would be "sailor-friendly", and require only minimal training (principally in laser safety), and simple in operation. It would only need to be pointed over the side of the ship and activated, returning one value of the attenuation (or more than one if marine layering is present).

PHASE I: Perform the research and development needed to prepare a preliminary design of the device, to include considerations of laser safety, and algorithm and software required to perform the analysis;

PHASE II: Construct a field-testable prototype of the device, preferably including data analysis on-board the device, but at a minimum including the necessary data analysis software to be operated off-board in conjunction with the measurements.

PHASE III: Complete (if necessary) integration of on-board data analysis, and shall perform the necessary engineering steps to productize the device to meet shipboard use. With slightly more sophisticated software, the presence of marine layering, and the location of the layers, could also be determined.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Oceanographic research, and (if sufficiently inexpensive) in civilian evaluation of scuba dive sites by commercial dive operators, and in performing benthic layer location for the fishing industry.

REFERENCES:

1. J. R. Apel, Principles of Ocean Physics, Academic Press, San Diego, 1987

2. ANSI Z136.1 -2007 Laser Institute of America, Orlando, 2007

3. www.is.northropgrumman.com/systems/almds_gallery.html (ALMDS)

4. www.globalsecurity.org/military/library/budget/fy2001/dot-e/navy/01amc.html (RAMICS)

KEYWORDS: sea water; optical attenuation; electro-optic; laser; sensor; measurement.

N093-206 TITLE: Compact Dipping Sonar for Unmanned Surface Vehicles (USVs)

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

ACQUISITION PROGRAM: PMS403: Unmanned Surface Sweep System & USVs; PMS420: LCS Mission Modules

OBJECTIVE: To develop a compact dipping sonar system optimized for Unmanned Surface Vehicle (USV) anti-submarine warfare (ASW) missions.

DESCRIPTION: The Navy's Littoral Combat Ship (LCS) is the centerpiece for using unmanned vehicles (UVs) in conducting mine countermeasures (MCM), anti-submarine warfare (ASW), and surface warfare (SUW). Unmanned Surface Vehicles (USVs) are a common component within the mission packages currently in development to carry out these warfare missions.

Dipping sonar will be a key mission package supporting ASW operations. The current effort depends on modifying a dipping sonar designed for and deployed from helicopters. The AQS-13 is the in service helicopter dipping sonar. Airborne Low Frequency Sonar (ALFS) is a next generation helicopter ASW dipping sonar. Helicopter dipping sonars are not optimized for USVs, where space is a premium and weight constraints limit the amount of desired equipment. In some instances, the stern of a USV has been observed to dip near water surface level under the heavy load of an attached sonar. This topic requests innovative design approaches to replace the current sonar with one of reduced size, payload, and improve acoustic performance. The effort will require innovative concepts and design cross the whole sonar system, not a re-engineering of the current system. Proposed solutions should consider the entire system, including array design, transduction approaches, innovative handling systems, cable design, electronics, etc. Solutions may comprise new materials (including structural, transduction, and cable materials), and/or synergistic design approaches that reduce system size, weight and complexity. A successful effort will enable a more rapid adoption of these mission packages. System commonality between USVs and helicopters is also encouraged; helicopters may also benefit from an improved sonar system because of space and weight considerations.

PHASE I: Develop a conceptual design of an improved dipping sonar system for a USV. The design should include a tradeoff study and performance comparisons with legacy systems. Conceptual Interface control documentation should be created for the design.

PHASE II: Develop a prototype system that can be integrated onto a USV in Phase III upon successful testing. Evaluation of the prototype could be on a platform of opportunity, which may include a RHIB boat or commercial ship.

PHASE III: Integrate and test of the system on a USV.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be applicable to applications involving USVs, such as oil and gas exploration, search and rescue missions, commercial salvage, harbor and coastal surveillance for homeland defense especially in high alert conditions.

REFERENCES: (References supply information and do not endorse a particular approach or product.)

1. The Navy Unmanned Surface Vehicle (USV) Master Plan: www.navy.mil/navydata/technology/usvmppr.pdf

2. Wallace, George, Whalen, Joseph E. Low-Frequency Dipping Sonar on A Rigid-Hulled Inflatable Boat. Sea Technology. August, 2005.
http://findarticles.com/p/articles/mi_qa5367/is_200508/ai_n21378158/pg_1?tag=artBody;col1

3. Military sonar upgrading methods developed at Gdansk University of Technology, Marszal, J.; Salamon, R.; Stepnowski, A. Oceans 2005 - Europe Volume 1, Issue , 20-23 June 2005 Page(s): 489 - 494 Vol. 1 http://ieeexplore.ieee.org/Xplore/login.jsp?url=/iel5/10104/32366/01511763.pdf?tp=&isnumber=&arnumber=1511763

4. AN/AQS-13 Series Sonar Systems (United States), Sonar Systems - Airborne Dipping Sonars. http://www.janes.com/extracts/extract/juws/juws0228.html

5. Robert Been, David T. Hughes, Arjan Vermeij See http://www.janes.com/extracts/extract/juws/juws0228.html

6 Airborne Low Frequency Sonar (ALFS). http://www.raytheon.com/capabilities/products/alfs/

7. Heterogeneous underwater networks for ASW: technology and techniques June 2008 http://www.nurc.nato.int/publications/pubs/2008/NURC-PR-2008-001.pdf

KEYWORDS: Unmanned Surface Vehicle; USV; Littoral Combat Ship; LCS; dipping sonar, ASW

N093-207 TITLE: Innovation for Application of Unmanned Station-Keeping Sea Surface Platforms

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO LMW: PMS (depending on application): 340, 403, 408, 420, 480, 485

OBJECTIVE: To develop an innovative product or process applicable to a creative, yet practical, warfare application of low observable, unmanned station-keeping sea surface platforms.

DESCRIPTION: The Program Executive Office for Littoral and Mine Warfare (PEO LMW) contains a number of program offices the missions of which stand to benefit from the U.S. Navy and private sector investment in long endurance, low observable, unmanned station-keeping sea surface platforms. Such platforms include semi-submersibles but not Unmanned Underwater Vehicles. Of particular interest are platforms which are low profile and, so, not easily observed and which are easily deployed and retrieved. The ease of deployment and retrieval and other factors such as endurance on station depend on the application proposed.

This topic solicits development of an innovative product or process and its application to a new or creatively enhanced use of such platforms. Successful proposals will offer the innovation and describe how its implementation will achieve the proposed application. Offerors, consequently, are being provided a broad opportunity for product or process innovation so long as they also convincingly describe how its application will be carried out. The successful product or process will allow fulfillment of the proposed application in an affordable, elegant, practical manner with minimal impact on the other systems involved in executing the particular mission.

An innovative product or process is one which would be covered by SBIR Data Rights. Innovative proof of concept products or processes in this case can be developed for such areas such as: station-keeping ability; energy harvesting technique; cloaking; platform subsystems such as energy sources, guidance and control, sensor, communications, and the like.

Application areas for PEO LMW program offices include communications from underwater to surface and/or air, including over the horizon and satellite; sensing for surveillance, defense, prosecution, and environmental monitoring (for acoustic performance prediction or for "bad things"). See Reference 1 for more specific descriptions. Proposals should identify a specific application or a closely related set of applications and explain how the innovative product or process will be key to enabling its achievement.

Development of platforms from concept to prototype will not be funded under this topic. The Phase II effort is expected to achieve full exploratory development of the innovative product or process. Offerors are encouraged, on the other hand, to base their proposed applications on combinations of existing platforms and associated hardware and software that have been demonstrated at least through exploratory development, preferably through advanced development. Doing so is likely to minimize the cost and rick of transition. This guidance suggests that proposals may require the integration of a variety of disciplines.

Under References below and during the Pre-Solicitation period no references will be provided for private sector USVs to avoid inadvertent omissions and the appearance of endorsing any USV. Any mention of specific USVs in government documents is not intended as an endorsement of one USV over another.

PHASE I: Develop an in-depth proof-of-concept of the innovative product or process. Describe the application of the innovation and how the innovation will enable its achievement. Include a plan for demonstration in Phase II of the full exploratory development stage. Depending on the application, the demonstration might or might not physically include other assets. Simulation could be used where practical as a substitute for other assets.

PHASE II: Carry out the demonstration of the innovation in the proposed application either with actual hardware and software, simulation, or a combination.

PHASE III: Support the conduct and assessment of a full demonstration of the proposed application. Transition the system to production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Station-keeping USVs have a range of applications related to, but separate from, naval warfare. They include homeland defense, environmental pollution monitoring, marine species monitoring, and oceanographic research.

REFERENCES:
1. PEO LMW Overview and link to PEO LMW Fiscal Year 2008 Annual Report
http://acquisition.navy.mil/rda/home/organizations/peos_drpms/peo_lmw

2. The Navy Unmanned Surface Vehicle (USV) Mater Plan 23 July 2007
www.navy.mil/navydata/technology/usvmppr.pdf

3. Unmanned Surface Vehicle Operational Deployment 1997 Final Report
http://www.sarich.com/usv/USVBahrainReport/USVBahrain.html

4. Autonomous Navigation and Obstacle Avoidance for Unmanned Surface Vehicles
http://www.spawar.navy.mil/robots/surface/usv/usv.html

5. Association for Unmanned Vehicle Systems International
http://www.auvsi.org/

KEYWORDS: low observable ocean platform, semisubmersible, Unmanned Surface Vehicle, USV, station keeping, surveillance, communications, environmental monitoring

N093-208 TITLE: Innovative Coatings for Prevention of Inter-Granular Corrosion in Sensitized 5000 Series Aluminum Alloys

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 502, CGX Program, ACAT I

OBJECTIVE: The objective of the project is to develop and implement new innovative approaches and techniques for a more durable coating and application process in order to mitigate inter-granular corrosion in sensitized 5000 series aluminum alloys.

DESCRIPTION: Current marine-grade aluminum alloys (5XXX-series) are commonly used in naval combatants and are known to be susceptible to sensitization. Once the aluminum material becomes sensitized, it is vulnerable to inter-granular corrosion which manifest as stress corrosion cracking (SCC) and exfoliation corrosion. SCC is common in sensitized, recrystallized, high-strength, marine, aluminum alloys in naval environments subjected to prolonged tensile stresses. Exfoliation corrosion affects sensitized, un-recrystallized plates and sheets in marine environments. Material degradation due to sensitization has been observed in the fleet in the form of SCC cracking problems on the Guided Missile Cruisers (CGs) and exfoliation from the Vietnam-era Swift boats. Currently, ASTM standards and screening tests can ensure that materials at the time of purchase are not sensitized, but are not intended to predict resistance to sensitization in the future. The marine environment, coupled with elevated temperatures, can lead to sensitization and subsequent degradation from corrosion and conventional navy paints have not been an effective environmental barrier.

This topic seeks to explore the development of innovative new approaches that will provide a durable, low-cost coating to provide a sensitization barrier as experience has shown that 5000 series aluminum alloys are likely to become sensitized over time. Applicable processes to apply the proposed coating concept in a shipyard environment are also required. Coating and application process must be environmentally compliant with Navy requirements. Assessments of coating system through modeling and simulation and/or small-scale prototype demonstrations are encouraged. The key factors to consider are the effectiveness, moisture and ionic species permeability, adhesion, durability, cost, environmental compatibility, effects from non-skid treatments, compatibility with silicone-alkyd topcoats, and adaptability to the shipyard environment.

PHASE I: Demonstrate the feasibility of a coating and application process in order to mitigate inter-granular corrosion in sensitized 5000 series aluminum alloys by providing a robust environmental barrier for aluminum substrates. Perform bench top experimentation, where applicable, as a means of demonstrating the identified concepts. Establish validation goals and metrics to analyze the feasibility of the proposed solution. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Formulate, demonstrate, and validate coating and associated processes to implement the concept defined in Phase I. In a laboratory environment, conduct testing, evaluate the coating system for efficacy, moisture and ionic species permeability, adhesion, durability, topcoat compatibility and process repeatability, and finalize the coating system. Develop a final specification for the coating and application process documentation.

PHASE III: Develop production quality, low cost, and more durable coating and application processes in order to mitigate inter-granular corrosives in sensitized 5000 series aluminum alloys for military and commercial implementation onboard naval platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The coating and application processes developed for the Department of Defense is equally applicable for use in commercial boating industry.

Development of an effective coating would have considerable benefits in the commercial industry which must consider the same material degradation effects where 5000 series alloys are used.

REFERENCES:
1. Seattle-Post intelligencer, “Aloa Awarded $59.6 million for replacing metal” June 28, 2006

2. Stress Corrosion Cracking of Aluminum Alloys - www.key-to-metals.com/Article17.htm

3. Oguocha et al, “Effect of Sensitization Heat Treatment on Properties of Al-Mg Alloy AA5083-H116”, Journal of Material Science, DOI 10.1007/s10853-008-2606-1.

4. Bushfield, Harold Sr., Marc Cruder, Rendall Farley, and Jim Towers, "Marine Aluminum Plate – ASTM Standard Specification B 928 And The Events Leading To Its Adoption". Presented at the October 2003 Meeting of the Society of Naval Architects and Marine Engineers, San Francisco, California.

KEYWORDS: Aluminum; corrosion; crack; coating; alloy; sensitization;

N093-209 TITLE: Manufacturing and materials for Radar/EW Power System Stability

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: NON-ACAT X-Band and S-Band Radars and EW Arrays

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop designs, manufacturing processes and/or materials that provide affordable high performance Radar/EW power systems and components. Improve power system performance and stability while reducing power system cost and reducing T/R module life degradation caused by power transients and variations.

DESCRIPTION: Phased arrays for high power Radar and EW applications require improved electrical power systems, these power systems are a significant portion of the overall system in terms of cost, weight, power, thermal load. This topic seeks new technologies that will significantly reduce power system requirements in terms of size, weight, thermal load and cost. Navy electronically steered arrays for radar and EW systems require new and innovative power system technologies that will reduce overall system weight, size, and cost while providing increasingly higher power density, improved transient response and pulsed current capability. Power component improvements in packaging, manufacturing processes and innovative materials are sought that will significantly lower noise, weight, size, cost and that have faster transient response, higher efficiency, and higher power density as compared with existing state of the art (see references).The goal of this topic is to significantly improve system level performance of power system technologies focused on surface navy Radar and EW system T/R modules. Significantly improved power supply performance and stability is sought that will minimize T/R Module life degradation caused by poor power stability. Items of interest include:
- Low cost manufacturing processes and materials
- low inductance, high frequency, high common mode isolation, high corona voltage, low profile, greater than 1kW power capability transformer with 1 to 7MHz 3dB frequency.
- high Q, low profile inductor with 1 to 7MHz 3dB frequency
- high performance ferrite material with capability of 1 to 7MHz 3dB frequency
- Metal core or insulated metal substrate board with high thermal conductivity, low inductance line capability, and high corona voltage.

PHASE I: Perform the required R&D to establish basic feasibility for the proposed technology and model the performance of the proposed power system technology, manufacturing processes and/or components to insure that it satisfies the intent of this topic.

PHASE II: Develop manufacturing processes and build prototype power components, modules, technologies down selected from Phase I feasibility studies. Evaluate the stable power technology electrical performance over anticipate operational temperature ranges and meet, or exceed, this topics stated objectives. Demonstrate critical new manufacturing processes and test hardware performance that establish feasibility of the evaluated technologies and manufacturing processes to provide production ready power components, modules, technologies. In addition, conduct preliminary cost modeling to show that the technology is cost competitive with current State of the Art (SOA) power system components that the evaluated technology is to replace in an anticipated Navy IWS radar or EW system.

PHASE III: Establish manufacturing processes and quality controls to provide production quality power system components, modules of interest to Navy IWS Radar and EW applications. Manufacture power system components, modules to validate final processes and conduct electrical and environmental performance testing of the contractor's technology. Validate cost modeling to show that the technology cost is competitive with existing State of the Art (SOA) power system hardware.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed technologies will have applications in private sector radar systems as well as on numerous military systems requiring improved power system power density at lower cost.

REFERENCES:

1. R. W. Erickson, Fundamentals of Power Electronics, New York, Chapman and Hall, 1997.

2. Mohan, Undeland, and Robbins, Power Electronics: Converters, Applications, and Design, New York, John Wiley & Sons, 1995.

KEYWORDS: Radar, phased array, EW, power components, fast transient response, pulse current load

N093-210 TITLE: Determining the Depth of Penetration During Submerged Arc Welding

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: NAVSEA's National Shipbuilding Research Program (NSRP)

OBJECTIVE: The objective of the topic is to develop and implement new, innovative Submerged Arc Welding (SAW) technologies that can impact the cost and cycle time to construct, modernize, maintain and repair the Navy's fleet.

DESCRIPTION: SAW is a common welding method used in most of the automated, plate, butt-welding processes such as panel-line assemblies. Many plates are welded using SAW tractors and are welded from both sides to ensure full penetration and acceptable quality. When two-sided welding is required, it is performed in a multi-step process requiring significant material handling, back-gouging, and redundant welding. In simplified terms, a double-sided welded involves welding from one side, flipping the plate, and then completing the weld from the other side. Because most applications of SAW require full penetration, the key to double-sided welding is ensuring that the "backside" weld fully penetrates and fuses into the weld deposited on the first side. In most cases, full penetration is assured by back-gouging prior to welding of the second side (or backside weld). Back-gouging can be defined as the removal of base-metal as well as weld-metal from the side opposite of a partially welded joint to facilitate complete joint penetration. Back-gouging may be carried out by chipping, flame gouging, arc-air gouging, or grinding; with subsequent cleaning of the gouged area to ensure a clean, sound surface is available for depositing the second side weld. The depth and width of the back-gouged area is what is the minimum necessary to guarantee that the backside weld can be deposited against sound metal and can completely penetrate the weld root area. Thus, back-gouging generally requires removal of base metal as well as some (and often significant amounts) of the weld metal that was deposited from the first side. It follows, that elimination of back-gouging could significantly save time a cost through: (1) eliminating the steps associated with the back-gouging process and (2) reducing the volume of weld metal needed to complete the backside. This so-called, “no back-gouge” method is approved in limited cases. One major issue limiting the use of the “no back-gouge” method is the inability to reliably control penetration. If one could accurately control weld penetration from the two sides (e.g., ensuring 60% penetration from both sides), then one could extend the use of “no back-gouge” procedures to greater thicknesses. Similarly, for field connections in which SAW is used to weld the top side and overhead Flux-Cored Arc Welding (FCAW) is used to complete the second side, penetration control could maximize the amount of SAW without the chance from a blow through.

Most structural butt joints require full penetration to pass non-destructive evaluation acceptance criteria (MIL STD 2035A) and to ensure adequate performance. Currently, there is no effective in-process method of determining depth of penetration. Thus, for double-side weld applications, the costly back-gouge method is used. As the submerged arc process does not permit the welder to observe the welding process (due to the cover layer of flux), it is not possible for the welder to monitor the weld pool to visually determine weld quality. The two primary methods of non-destructive testing used to ensure adequate weld penetration in double-sided welds are ultrasonic testing and radiography; neither method can be used while welding is in process.

This topic seeks to develop the methodologies and associated enabling technologies to accurately control the depth of weld penetration during the SAW process. This capability, especially if performed in real-time, could expand the currently used "no back-gouge" method beyond the today’s limits, significantly increasing cost savings. In-process weld monitoring will also reduce the iterative process required to determine the initial welding parameters for new applications. The largest technical challenge of this topic is developing a weld-depth monitoring method and equipment that can overcome the lack of weld pool visibility inherent in the SAW process. Therefore, an innovative, potentially high-risk solution is required. A successful, in-process SAW penetration-monitoring technology will have a tight penetration tolerance, must be capable of monitoring varying weld gaps due to fit up variations, must produce welds capable of meeting the requirements of MIL-STD-2035A, and will maintain or increase shipyard throughput on the panel welding line. The system will also need to be ruggedized to meet the harsh shipyard environments including resistance to high temperatures and weld splatter. The innovative solutions must be compatible with current shipyard practices and processes.

This topic also seeks innovative scientific and engineering solutions to inefficiencies in long-standing ship construction processes. This topic offers an opportunity to infuse new ideas and innovations into the domestic shipbuilding industry. Of particular interest are initiatives with a clear business case. 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 might be transitioned into the shipbuilding industry. National Shipbuilding Research Program (NSRP) members are available to provide guidance and assistance in the identification of common issues and needs. Contact with these resources is encouraged both prior to proposal development and during any subsequent SBIR-related activity. Teaming with a NSRP member is voluntary and will not be a factor in proposal selection.

PHASE I: Demonstrate the feasibility of an in-process method of accurately controlling and monitoring the depth of weld penetration during the SAW process. Demonstrate improvements being developed and also identify impact upon shipbuilding affordability. Include a first order Return-On-Investment (ROI) analysis for industry implementation and estimate potential Total Ownership Cost (TOC) reduction. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the Phase I design and demonstrate a working prototype of the proposed system. Perform a demonstration to validate the performance characteristics established in Phase I. A demonstration in a representative (i.e., shipyard) environment is preferred; however, a laboratory demonstration is acceptable if steps are taken to incorporate critical characteristics of the shipyard environment. Develop a detailed plan and method of implementation into a full-scale application within the US Shipbuilding and Repair Industry.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the Shipbuilding and Repair industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic shall be directly applicable to current military and commercial shipbuilding operation and repair practices. The products developed should find wide use in most heavy industrial plant/processing facilities such as the power or offshore oil industries and will be marketable to the shipbuilding and repair industry.

REFERENCES:

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

2. US Naval Shipyard information is available at http://www.shipyards.navy.mil

3. http://en.wikipedia.org/wiki/Submerged_arc_welding
Available at http://assist.daps.dla.mil/quicksearch/

4. MIL-STD-2035A, Nondestructive Testing Acceptance Criteria

KEYWORDS: Welding; SAW; NDT; NSRP; Butt Welding; Monitor

N093-211 TITLE: High Channel Count Optical Slip Ring

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMS401: Navy Future Sensors & Towed Array Programs: ACAT IV

OBJECTIVE: The objective would be to develop optical slip ring technology that allowed a higher channel density than commercially available at present. The final packaging into a device capable of surviving the harsh SSN ballast tank environment would be deferred until the optical issues could be demonstrated. The optical performance of each channel is low loss (less than 3dB at 1550 nm wavelength) and minimal back reflection (<-30dB).

DESCRIPTION: The high channel count (20 to 30) slip ring is mounted on a winch in the submarine ballast tank. The slip ring is in series with optical and electrical signals that transmit between the SSN host sonar and the electrical-optical TB-33 towed array. The towed array requires two power wires and 20 optical paths. The existing Electrical-Optical slip ring has only 10 fiber channels and 2 electrical channels, which restrict the TB-33 optical architecture, putting many acoustic channels on a single fiber. In the event of a single fiber failure, the submarine may experience a system performance loss that forces it to come "off station."

PHASE I: Phase one should investigate techniques for high channel count slip ring technologies. Lenses and prisms are acceptable techniques if they promote high channel density with low loss and very low back reflection at 1550 nm wavelength. Conceptual drawings showing how the new technology might be incorporated into the existing form factor should be included to determine suitability of further development. Additionally, a single channel test of proposed approach showing progress towards optical requirements would be very beneficial.

PHASE II: Phase II would yield a working prototype slip ring that would be evaluated against performance requirements within a lab environment.

PHASE III: During Phase III, the TB-33 program would procure sufficient quantities of slip rings to meet operational outfitting of TB-33. That would be a quantity of approximately 12 the first year followed by 6-8 annually for a total of approximately 50. In addition, the vendor would be expected to support periodic refurbishment and repairs at the rate of approximately 4 units per year.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Optical data and signals are the future of data systems. Optical slip rings can support many applications.

REFERENCES:

1. TB-33 Prime Item Development Specification

2. TB-33 EOSRA Assembly

3. OA-9070B handling system Tech Manual

KEYWORDS: Optical; Slip Ring; Handling Systems; Low-Loss; Low Back Reflection; Single mode Fiber

N093-212 TITLE: Non-Hermetic Passivation/Coating Processes with Integrated Electromagnetic Protection

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: NON-ACAT X-Band and S-Band Radars and EW Arrays

OBJECTIVE: Develop innovative Monolithic Microwave Integrated Circuit (MMIC) and circuit passivations and coatings that protect circuits from shipboard Phased Array Radar/Electronic Warfare (EW) Electronically Steered Arrays (ESAs) electromagnetic environments in addition to providing environmental protection.

DESCRIPTION: Passivation technologies that provide robust non-hermetic packaging and environmental protection of Transmit/Receive (T/R) module electronic circuits and MMICs have been demonstrated. This reduces T/R module assembly cost and helps enable affordable electronic steered arrays for Radar and EW applications. These passivation processes provide environmental protection but they do not protect the MMIC and T/R module circuit from shipboard and array level electromagnetic interference (EMI.) This currently requires metalized lids and electrical interference protection to be added to the T/R module assemblies which requires additional cost and creates potential for reliability issues of the modules. This topic seeks innovative approaches which would mitigate the need for additional lids and external RF interference protection. The incorporation of metal coatings, to provide EMI protection, can also negatively impact circuit performance. The technology of interest would provide EMI protection and environmental protection without degrading the electrical performance of the protected T/R module circuit while still focusing on affordability as a major performance issue.

PHASE I: Design, model, and/or evaluate integrated EMI protection non-hermetic packaging techniques meeting the intent of this topic. The metrics for success are: (a) no degradation of electrical performance (gain, current consumption, input/output impedance, S-parameters) and (b) maintenance of environmental EMI and moisture ingress/absorption protection while reducing the overall module assembly complexity and cost by 20 percent.

PHASE II: Develop manufacturing processes and build prototype test vehicle with the coatings, passivations, and encapsulations selected from Phase I. Demonstrate stable MMIC/ T/R module electrical performance over anticipate shipboard operational temperature and moisture ranges and meet, or exceed this topics stated objectives. Demonstrate critical new manufacturing processes and test hardware performance that establish feasibility of the developed technologies and manufacturing processes to provide production non-hermetic T/R Modules that do not require additional metalized lids to function in a shipboard RF environment. In addition, conduct preliminary cost modeling to show that the developed technology is cost competitive with current State of the Art (SOA) T/R module production processes.

PHASE III: Establish manufacturing processes and quality controls to provide production quality materials, coatings, passivations, encapsulates integrated onto T/R modules of interest to IWS Radar and EW applications. Manufacture T/R modules to demonstrate final processes and conduct electrical and environmental performance testing of the contractor's technology. Conduct cost modeling to show that the developed technology is cost competitive with current State of the Art (SOA) T/R module production processes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Coatings, passivations and encapsulation technologies that can provide environmental protection in addition to Electromagnetic Interference

(EMI) protection with minimal electrical performance degradation will have applications in commercial industries as well as on numerous military systems.

REFERENCES:
1. "GaAs MMIC Reliability Assurance Guideline for Space Applications", S. Kayali, G. Ponchak, R.Shaw, JPL Publication 96-25.

2. Bahl, I., and P. Bhartia, Microwave Solid State Circuit Design, John Wiley &Sons, Inc., New York, 1988.

3. "WASPP Program: Advanced Passivation for Advanced Packages and Harsh Environments", Reusnow, C.; Wheelock, S., Advanced Packaging Materials: Processes, Properties and Interfaces, 2001. Proceedings. International Symposium on Volume, Issue, 2001 Page(s):63 –67

KEYWORDS: Non-hermetic packaging; MMIC passivation; circuit board encapsulations and coatings; Transmit/Receive Modules; GaAs; GaN; X-band; S-band; Radar; EW; EMI;RF

N093-213 TITLE: Real-Time Hull Shape Monitor

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: NAVSEA Team Submarine PMS450

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop the capability to accurately measure the shape of a submarine hull 'real-time' as it operates. This ability would provide precise real-time locations of flank mounted sonar arrays. Such knowledge could be employed by acoustic signal processors to improve the performance and accuracy of multi-panel hull mounted arrays. Further potential exists for such technology to eliminate the need for ‘on-range’ calibration of multi-panel hull arrays in the fleet.

DESCRIPTION: To achieve maximum performance, in a multi-panel flank mounted SONAR system, the relative positions of the panels must be known with great precision. Present multi-panel sonar systems are installed to extremely tight tolerances. Despite this, it is necessary to conduct costly at sea calibrations of each sub to ensure system performance.

Real-time knowledge of panel positions would allow the SONAR signal processing software to compensate for the static and dynamic misalignment of panels as the boat changes operating environments, boosting system performance and potentially eliminating the need for costly calibration exercises.

Current state of the art shape measurement systems are not capable of monitoring the shape of a body of the size of a submarine, nor are they able to provide the degree of precision required by this effort. To date, scientists have developed but not successfully demonstrated the technologies that measure the dynamic shape of small diameter (~3.5") flexible bodies to accuracies of 0.5" spanning a length of 50 ft. The effort proposed here would look at measuring the shape of a body over 100 times that diameter, over 4 times that length, and with 10 times the precision.

The challenge/risk presented by this effort would take the current state of the art to a new level of complexity, first by increasing the amount of instrumentation and its integration into a large structure; second by the development of algorithms capable of manipulating the vast amount of data so as to accurately report the shape of a large diameter body, like a submarine, real-time, with a high degree of precision.

PHASE I: Determine the scope of instrumentation necessary and the feasibility of developing algorithms necessary to monitor and record the shape of a submarine hull and report the relative x, y, z positions of discrete points to within 0.05" over a length of 200' as the vessel operates.

PHASE II: Complete the R&D and assemble a functional proto-type that can be used to evaluate the capabilites of the proposed shape monitoring technology in a laboratory. The potential also exists to demonstrate the technology using a 1/4 scale model of the Virginia hull in a controlled fresh water environment.

PHASE III: Develop a proto-type shape measurement system that can be installed on a Virginia class submarine and evaluate its performance, using the output to provide SONAR signal processing software the real-time positions of array panels.

The system shall be installed and evaluated, comparing the performance of a multi-panel SONAR with and without realtime position inputs on a test range used for calibration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology can be used on any vehicle, structure, or body to monitor its shape with extreme precision in a dynamic environment. Industries which might benefit are aerospace, shipbuilding, geological studies, power generation and propulsion.

REFERENCES:
1. Eric Udd, "Fiber Optic Sensors An Introduction for Engineers and Scientists", John Wiley and Sons Inc., 2006.

2. A. Othonos and K. Kalli, "Fiber Bragg Gratings: Fundementals and Applications in Telecommunciations and Sensing", Artech House Inc., 1999.

3. Todd, M., D. Mascarenas, L. A. Overbey, T. Salter, C. Baldwin, and J. Kiddy, “Towards Deployment of a Fiber Optic Smart Tether for Relative Localization of Towed Bodies,” Proceedings: SEM Annual Conference and Exposition on Experimental and Applied Mechanics, Paper No. 92, Portland, OR, 2005.

4. Bernecky, W. Robert, "Determination of Location Deviation Offset for Wide-Aperture-Array Panel", NUWC-NPT Technical Report 11,828, 1 July 07.

KEYWORDS: SONAR; flank arrays; shape measurement; submarines; Virginia; ship building

N093-214 TITLE: At-sea Reliability with Predictive Modeling

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

ACQUISITION PROGRAM: Submarine Combat Systems Program Office (PMS425) ACAT III

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The goal is to develop innovative technologies that focus on avoiding performing planned and unplanned maintenance during tactical operational deployments by predicting when maintenance should be performed on a non-interfering basis. These innovative technologies should consider the following as a minimum:
- Scheduled Planned Maintenance
- Real-time Failure Analysis
- Predictive Failure Analysis
- System Monitoring of Software and Devices

DESCRIPTION: In the current shipboard environment, maintenance is performed by a standard or during casualty events. A variety of data is collected by numerous methods to determine the conditional state of the system. However, the process is performed manually and takes a long time to complete each event. Personnel attempt to ascertain whether scheduled or emergency maintenance is required to correct known problems, or predict when problems may occur. However, there is currently no comprehensive onboard solution for predicting when issues may arise. Due to this fact, some amount of maintenance may be done unnecessarily, or in contrast, some activity may not be accomplished that could result in a problem surfacing during some critical activity such as during a weapon launch. Additionally, the manual processes are subject to human error, require crew training, and don't take advantage of available processing within onboard systems. Finally, there is no linkage to off-board distance support activities. What is needed is a method for forecasting equipment failures utilizing future predicted shipboard problems in critical onboard systems and equipment. This may include utilizing real-time monitoring devices combined with data collection tools and algorithms that can predict equipment failures, or predict when to schedule maintenance. By utilizing sophisticated statistical analysis tools, evidence of statistical anomalies and equipment can be collected that could predict and warn operators of impending equipment failures. Additionally, real-time monitoring by Smart Sensors would also be incorporated into the conditional maintenance concept to measure such things as temperature and vibration for example, which could be collected for analysis by a program that modeled predicted breakdowns based on past data. Additionally capabilities would be incorporated to avoid false positives and to ensure that personnel did not erroneously replace or repair equipment that in reality had no issues.

PHASE I: Research & develop computing models that can be utilized to predict future equipment behaviors. Examine what standard and smart monitors could be installed onboard a submarine platform as well as data collection/analysis systems that could be used to collect equipment data. Document research in a system design document that can be used for Phase II prototype development.

PHASE II: Based on the outcome of the phase I effort design and develop a prototype predictive fault modeling system that will be evaluated in submarine laboratory environments using existing submarine hardware. The prototype should be able to show the condition of the system in realtime. The prototype system should be able to handle precationary as well as emergency maintenance scheduling based on data analysis from system sensors with little or no manual input.

PHASE III: Develop a full scale model meeting all requirements for installation and final testing onboard an operational submarine. Upon completion of testing develop and produce a system for instalation on operational submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system can be used in various commercial settings such as monitoring of both commercial and military vehicles as well as monitoring nuclear power plant and other critical civilian infrastructures. System could also be used to monitor power grids for possible outages based on past use and predicted human behaviors.

REFERENCES:
1. Modeling Surprise – MIT Technology Review, March/April 2008
(http://www.technologyreview.com/read_article.aspx?id=20243&ch=specialsections&sc=emerging08&pg=2)

2. Bayesian Inference – Wikipedia: http://en.wikipedia.org/wiki/Bayesian_analysis

3. Smart Monitors for reducing equipment costs and monitoring failures -
http://www.globalspec.com/reference/8007/SensiNet-Chiller-Plant-Monitoring-System-Reduces-Operating-Costs-and-Predicts-Equipment-Failure

KEYWORDS: submarine, data collection, data analysis, predictive monitoring, Bayesian Statistics, Smart Monitors, Performance Monitoring/Fault Localization (PM/FL)

N093-215 TITLE: Multi-Platform Active Heave Compensation System

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

ACQUISITION PROGRAM: Submarine Rescue Diving and Recompression System (SRDRS) ACAT IV

OBJECTIVE: Design and develop an active heave compensation system for a launch and recovery system that can be installed on any platform, without having to know the platform's motion characteristics or tune the system prior to operation.

DESCRIPTION: The SRDRS is the United States Navy's primary rescue asset to rescue personal from a disabled submarine. The SRDRS concept of operations requires that the rescue asset be mobilized and onsite with 72 hours. The SRDRS does not have a full capability to reduce heave and uncouple the motion between the tethered ROV and the vessel. It is desired to have an active heave compensation system that does not require to be tuned for each vessel and has the capability to reduce heave disturbances by 80% in up to Sea State 4, as defined in DOD-STD-1399, section 301A.

Without a heave compensation system, the LARS operations of the SRDRS's Pressurized Rescue Module (PRM), or tethered ROV, has to be operated in manual mode, relying on operator proficiency. Operator fatigue can occur because of continuous operations, increasing the risk of damage to the PRM and the LARS lift lines, especially in higher sea states. The system should have two modes of operation, constant tension and heave compensation, and also provide the capabilities to smoothly transition from one mode to another. In constant tension, the LARS lift lines should stay at a given tension set-point while raising and lowering the PRM. The heave compensation mode should be able to keep the PRM at a given depth.

PHASE I: Conduct conceptual studies/R&D/analysis determining possible methods to reduce heave experienced by the system on multiple platforms without having to tune the system or knowing the platform's motion characteristics. The concept should include a preliminary design of the system, including the algorithm and necessary system hardware. A review of the existing system and how the proposed concept applies would be of benefit. Documentation related to the status of the current system will be given to the awardee as GFI.

PHASE II: Develop detail design of the Phase I preliminary design and demonstrate, via simulation the system requirements, including the heave reduction on multiple platforms.

PHASE III: Upon meeting the U.S. Navy's systems requirements, the active heave compensation system will be certified as a capability for the SRDRS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The multi-platform active heave compensation system has a potential use for the commercial nad scientific communities to operate ROVs that use LARS on multiple platforms without having to tune the compensation system. In addition to the multiple ROVs that the Navy operates, the Navy has other systems, such as TAVTS (Test Article Vehicle Transfer System), in which heave compensation is used. Currently these systems are installed on platforms where the motion characteristics are known or the system has to be tuned. The final design could also be applicable for subsea mine reconnaissance.

REFERENCES:

1. Lainiotis, D.G,; Plataniotis, K.N.; Menon, Dinesh; Charalampous, C.J., "Adaptive Heave Compensation via Dynamic Neural Networks", Proceeding of OCEANS '93, pp. I243-I248 vol. I.

2. DOD-STD-1399, Section 301A

3. NAVSEA ltr 9070 Ser394RR/0114 of 25 Jan 2008 -Software Requirements Specification (SRS) for the Submarine Rescue System Handling System, Rev 6.0 of 21 Jun 2007

4. NAVSEA Document TM304147 Rev D, Performance Specification of the SRS Handling System of 26 May 2005

KEYWORDS: Heave Compensation; algorithm; launch and recovery system; subsea; sensors; control

N093-216 TITLE: Magazine Lightweight Synthetic Decking

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Aircraft Carriers

OBJECTIVE: The proposed topic intends to focus innovation on a cost effective, lightweight alternative to latex concrete for air launched ordnance and ammunition magazine decks. Advanced lightweight materials are becoming the norm for new designs in buildings, aircraft, autos, watercraft, etc. New, synthetic decking materials are increasingly being used in applications that traditionally utilize wood. A synthetic material with characteristics capable of equaling the performance of concrete to provide a level working surface for shipboard ordnance handling and stowage is a technological challenge. A relatively lightweight (50% or more weight reduction over the current approximate 350 tons of MIL-D-21631 latex concrete per ship), easily installed and removed or repaired synthetic material for the demanding environment of CVN and LHD magazines is the objective of this topic.

DESCRIPTION: The Universal Tie-Down System (UTDS), installed in aircraft carrier and large deck amphibious ship magazines, consists of deck tracks constructed of C-channel that act as anchor points for weapons tie-down chains. The 3” wide C-channels are spaced on 9” centers, creating a 6” gap between them. With no filler material, the deck tracks create an obstruction 7/8” -1” high from the deck plate. To provide a level deck surface for ordnance handlers and fork trucks to operate on, latex concrete is used to fill the gaps between the C-channels. In accordance with MIL-D-21631 Deck Covering, Latex Concrete, the deck covering after curing shall not exceed 12.25 lbs per square foot for a thickness of 1”. Also, per MIL-D-21631, the deck covering must be resistant to impact, elevated temperature, indentation, wear, etc. and have non-slip properties. While a new material may have somewhat different requirements than those of MIL-D-21631 depending on its physical properties, any new specification to be written for it will have a similar scope i.e., “…a non-sparking, fire retardant… deck surfacing for use over aluminum or steel decking or between channels in the holds of ammunition spaces.”

The steel deck plates aboard ship and upon which the new material is to be installed, do not themselves provide a perfectly level surface and irregularities must be compensated for. Concrete applied by trowel and screed inherently compensates for irregularities in the deck plates. Should a substratum be required for the new decking, the weight of that substratum must be added to the weight of the synthetic decking when calculating weight savings, likewise for any necessary fastening hardware. Together with the adjoining C-channel, an overall uniformly level surface is desired; an acceptable margin for minor irregularities will be determined. MIL-D-21631 rev.A will be used as a guide in determining margins for properties such as flow or slip, coefficient of friction, impact resistance, live load resistance, etc. It is not, however, the topic writer’s intent to mandate strict adherence to MIL-D-21631A and its referenced specifications so as to impede innovation.

This Topic requires that innovative R&D be conducted to develop a new, lightweight, synthetic material that has preferably lower combined acquisition, installation and maintenance cost than latex concrete, that can provide a level and durable, fire, impact and slip resistant surface in aircraft carrier and large deck amphibious ship magazines. Solid or liquid state at installation is allowable, however in either case, a justifiable case for replacing latex concrete must be made.

PHASE I: Conduct the needed R&D to develop a concept proposal for affordable, lightweight, durable, non-sparking, slip resistant material for use in shipboard magazine spaces. Using the existing latex concrete and MIL-D-21631A as a reference, clearly show margins of the proposed material properties that fail to meet or exceed the properties of latex concrete. Explain the trade-offs that may be necessary to achieve the desired performance level. Explain any compensating measures that would mitigate the effects of less desirable properties should they exist. Explain and justify any ASTM, UL or other test methods or qualification steps that may be commonly used in synthetic materials manufacturing that would supersede, replace or supplement those in MIL-D-21631A for the proposed material. Describe and illustrate the installation process and any necessary preparatory steps such as mixing, or additional materials such as adhesives, fastening hardware or a substratum layer. Perform a detailed weight analysis clearly showing the estimated weight savings. Perform a first order of fidelity business case analysis of the proposed material vs. latex concrete considering acquisition, installation and maintenance costs including repair and replacement. Present findings in a Final Report with data, photographs, illustrations, experiments, related work, etc. to demonstrate the feasibility of a lightweight synthetic decking material for use in U.S. Navy shipboard magazines.

PHASE II: Complete the R&D identified in the Phase I final report and using MIL-D-21631A or other predetermined specification(s) as a guide, prepare test article specimens as necessary to conduct a series of qualification tests. Tests shall include but are not limited to: weight, resistance tests for impact, indentation, flow, shear, moisture absorption, wear, fire, sparking, electrical conductivity, live load and a test of nonslip properties. Tests can be conducted at the proposing company's facility, U.S. Naval laboratory such as NSWCCD Philadelphia and/or independent testing laboratory satisfactory to the TPOC. A larger test specimen will be produced for actual load testing. Envisioned is a UTDS test area 10' x 10' or larger, complete with C-channel and the proposed concrete replacement. A series of tests simulating shipboard operations will be conducted using a 4,500 lb capacity reach and tier fork truck, ordnance loads and chain tie-downs typically found in aircraft carrier magazines. Based on the results of this test and other factors, a dynamic test of the UTDS test bed and stowed ordnance loads and MHE on a ship motion simulator may be warranted. A shock test in accordance with MIL-S-901D is a potential Phase II option activity.

PHASE III: Partnered with a prime contractor, a manufacturing and installation study will be conducted to determine the most cost effective and efficient production and installation methods. Separate testing and marketing for commercial applications would also be a joint effort with, and possibly led by, the prime contractor. It is envisioned that following U.S. Naval laboratory testing, an independent evaluation of the proposed concrete replacement will be conducted by Northrop Grumman Newport News Shipbuilding (NGNNS) at the Virginia Advanced Ships and Carriers Integration Center (VASCIC) laboratory. CVN 72 or 73 RCOH and CVN 78 would be candidates for initial shipboard installation and testing in selected magazine(s). Proven successful, complete ship set new construction installation is envisioned beginning with CVN 79.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial sea, air and road shipping, barges and boats, docks, commercial and residential indoor-outdoor decking including decks, patios and walkways, staging areas, multi-level warehousing, roadways for bridges, portable and mobile magazines for law enforcement.

REFERENCES:

1. Military Specification MIL-D-21631A, Deck Covering, Latex Concrete

2. MIL-STD-1623E Department of Defense Design Criteria Standard Fire Performance Requirements and Approved Specifications for Interior Finish Materials and Furnishings (Naval Shipboard Use)

3. Military Specification MIL-S-901D, Shock Tests, High Impact, Shipboard Machinery, Equipment, And Systems, Requirements For

4. NAVSEA OP-4 Ammunition and Explosives Safety Afloat

KEYWORDS: lightweight materials, synthetic decking, magazine, concrete replacement, ordnance stowage, aircraft carrier

N093-217 TITLE: <u>Manycore, Resource Management, Dynamic/Static Application Analysis</u>

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

ACQUISITION PROGRAM: PEO IWS 1.0

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop innovative algorithms and novel approaches that can analyze the application characteristics (static and dynamic) to configure/manage the manycore chips in a future Navy computing plant, taking into account dynamic scaling of core processing elements as the processing demand increases or decreases based on external events.

DESCRIPTION: Today, one sees multi-core packages as commodity off the self hardware providing around eight (8) cores. These current commodity solutions tend to be homogenous in nature and are supported to some extent by popular operating systems such as Microsoft and Linux with limited support from real-time OS vendors. The ability to manage each core is limited by the current core architectures and services provided by existing operating systems. Currently most resource management techniques are associated with high availability focusing on single board single core processing. The next generation resource management approaches will have to understand the complex nature of 100's of processing elements interconnected via high speed data fabrics with applications that can span across complex memory architectures. Predictions by Intel and other semiconductor companies indicate that cores will most likely double every 18 months using 8 cores today we can produce a simple forecast that by 2012 the commercial market will see 32 cores. Today Tilera is marketing a TILE64 processor containing 64 core elements. The Navy is searching for solutions that will scale from dual core to at least 128 core elements. Any solutions should use existing standards based efforts as a starting point. Any improvements to existing standards should be brought back to the standard bodies for incorporation.

The Navy expects the next generation manycore chips will require the ability to manage resources such as: Turning on and off selected cores within a chip allowing power and energy management; adjusting voltages and frequency per core in order to boost temporary performance on a per core basis; managing the allocation of cache to individual cores either as shared or private supporting different performance needs; and managing the network that connects the numerous cores.

PHASE I: Research and investigate algorithms that can be used to allocate applications across manycore architectures. Also identify resource management services that will aid in the effective management of manycore architectures.

PHASE II: Using the research from Phase I, design and develop a model that expresses the ability to analyze application needs, allocate the application across the manycore architecture, and manage the computing plant to scale based on environmental demand.

PHASE III: Demonstrate that the algorithms can manage the complex manycore environment while achieving both resource management and desired performance. Additionally, document the design guidance that should be provided to application and infrastructure developers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The application of this technology is not limited to the DoD space and is directly applicable to various government (non defense) and private sector disciplines (e.g., IT, manufacturing, process control, finance…).

REFERENCES:
1. Thierry Collette, "Key Technologies for Many Core Architecture", CEA, LIST, www.mpsoc-forum.org/2008/slides/8-4%20Collette.pdf

2. John Sartori, and Rakesh Kumar, "Proactive Peak Power Management for Many-Core Architectures" , Coordinated Science Laboratory, http://passat.crhc.illinois.edu/rakeshk/techrep_proactive.pdf

3. "The ManyCore Shift", Microsoft Corporation, http://www.microsoft.com/presspass/events/supercomputing/docs/ManycoreWP.doc

4. Adrian Schupbach, Simon Peter, Andrew Baumann, Timothy Roscoe, System Group, Department of Computer Science, ETH Zurich, Paul Barham, Tim Harris, Revecca Isaacs, Microsoft Research, Cambridge, "Embracing diversity in the Barrelfish manycore operating system", http://people.inf.ethz.ch/troscoe/pubs/schupbach08.pdf

KEYWORDS: Multi-core. Many-Core, Resource Management, Power Management, Operating Systems, Open Architecture

N093-218 TITLE: Orthogonal Frequency-Division Multiplex (OFDM) Waveform Optimized for Power Limited Line of Sight (LOS) User Environments

TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

ACQUISITION PROGRAM: JPEO JTRS, Network Enterprise Domain (NED), ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and validate a new or improved OFDM data symbol design that provides robust performance when used in a LOS data link with low Signal-to-Noise Ratio (SNR), high rates of Doppler shift, and interference.

DESCRIPTION: OFDM systems are designed using data symbol modulation chosen to satisfy user traffic requirements and spectral bandwidth constraints. Fixed microwave links with little or no multipath degradation can support OFDM systems with very high efficiency data symbols, e.g., 64-QAM giving 6 bits/symbol can be used on 802.16e in some cases. However, under realistic mobile radio link conditions involving ground operation with multipath, OFDM modulation efficiency may be forced down into the range of 1 to 3 bits/symbol. If even more link range is desired beyond what these symbols can support, then fractional bit/symbol alphabets must be considered. Simple symbol repetition is one such case; the symbols can be combined either coherently or non-coherently. Another class of symbols that might be fruitful in this low SNR case is cyclic shift correlation symbols such as the Zadoff-Chu symbols, because they can yield high processing gain and can operate in high Doppler and low SNR environments. In addition, these symbols have the characteristic of reduced peak to average power ratio , which allows the transmit power to be increased (by reducing "back-off") thus increasing the net link margin.

In a military LOS tactical communications environment, the users are most often ground-based or traveling in aircraft. Ground users (both dismounted and in vehicles) typically have significant limitations in antenna height and performance (height less than 10 feet), and rugged rural or urban terrain creates a high level of multipath. This analysis will need to be based upon several realistic operational scenarios in urban, desert, mountain, ocean, and forested regions.

The following are some of the key environmental characteristics of interest: Stationary white Gaussian noise, impulse noise and narrowband tones and Rayleigh fading up to 5 path fading at up to 25 Hz fading rates.

PHASE I: Develop three or more OFDM symbol designs and demonstrate performance using modeling and simulation. This demonstration will need to show performance characteristics in multiple types of fading environments, with various types of interference in the environment, and in the presence of residual (uncorrected) Doppler rates from 0 Hz 100 Hz. . Investigate benefits erasure decoding to combat single OFDM symbol loss. Consider the relationship of symbol choice and coding choice and provide an analysis to determine possible advantages and disadvantages of each. Generate a final report documented and supported with citations, analysis and simulation results.

PHASE II: Create a more comprehensive software implementation suitable for development and capability demonstration using software-defined radios development platforms. Demonstrate the performance of the proposed approach. In order to demonstrate practical viability, estimate the digital processing requirements and software code size required to port and adapt the software to available Software Defined Radio platforms.Perform field testing to validate the waveform's performance and the accuracy of the model used in the simulations.

PHASE III: Enhance and port the software into the JTRS radio product lines. Support development and operational testing processes by users. Maintain and enhance capabilities of software to meet JTRS Enterprise requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: OFDM is used by both military and commercial wireless systems such as WiMax. The techniques developed as part of this SBIR will be directly applicable to improving the performance and affordability of commercial mobile networks.

REFERENCES:
1. Popovic, B.M., "Generalized chirp-like polyphase sequences with optimum correlation properties", IEEE Transactons on Information Theory, v38, Issue 4, July 1992, pp1406-1409.

2. Liru & Dubey, "Extended orthogonal polyphase codes for multicarrier CDMA system", IEEE Communication Letters, V8, Issue 12, December 2004, pp 700-702.

3. IEEE Standard 802.16e-2005

4. IEEE Standard 802.16-2004

5. Clarification from TPOC on Parameter Ranges and Channel Models, uploaded 8/25/09.

KEYWORDS: OFDM, JTRS, MANET

N093-219 TITLE: <u>Network Operations (NetOps) Data Transport Optimization Engine</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: JPEO JTRS, Network Enterprise Domain (NED) ACAT I

OBJECTIVE: To provide optimization of NetOps data transfer and a greatly simplified interface.

DESCRIPTION: The goal of this effort is to develop an understanding on how to dynamically determine the data that has high informational content. The goal also is to investigate and define a simplified interface that will allow all network management tools to communicate with each other. .

Today's networks are typically infrastructure backed networks. These networks are richly connected, reliable, and have a high bandwidth backbone with a stable topology. A tactical mobile ad hoc network, on the other hand, has very different characteristics. It is intermittently connected, very low bandwidth, and has a highly dynamic network topology. This network is much more complex than an infrastructure backed network and bandwidth resource is scarce with many applications and services competing for it constantly.

A number of schemes have been adopted to regulate network traffic when bandwidth is become scarce. One such scheme is Multi-Level Precedence and Preemption (MLPP). In a nutshell, MLPP requires that applications with higher precedence (or priority) be given preference over those with lower precedence when network resources are scarce. While schemes like MLPP are efficient in regulating network traffic, they do very little to reduce the bandwidth requirement of an application or service.

Currently, existing network management tools collect large volume of data and transmit 100% of those data over the network. This adds a network management overhead on the bandwidth. Nobody has defined the minimum set of NetOps data needed to effective manage the network. It is not necessary to analyze 100% of the data collected to infer the status of any network. This is mainly due to the fact that not all data are high in carrying information content. Algorithms must be developed to dynamically determine the set of data that has high informational content.

The other issue is currently there does not exist any interface by which all Network Management tools communicate with each other. While a number of interface definitions are available, they are very complex. Due to their complex nature, vendors of the commercial-off-the-shelf (COTS) tools are typically unwilling to adhere to those standards. In order to mitigate this problem, a simple interface that can handle NetOps data transfer must be defined and developed.

Once the algorithms for determining high informational content data has been developed and the simplest interface for transferring NetOps data has been defined, an engine must be created to perform the optimization and transport of the data. By having such a tool, the interactions between different tools can be made easy and the network management overhead on the bandwidth can be significantly reduced. The payoff from this technology will be a cost effective way to integrate all, current and future, network management tools.

PHASE I: Develop approaches for dynamically determining the set of data that has the most relevant information for the task being performed by the user. Determine how to dynamically control data gathering scope at the source and cross-network. Provide a paper documenting several approaches for determining relevant data dynamically. As part of the interface study, research and define the simplest interface and related processes, which can be used in order to transfer all NetOps information. Provide a paper defining the simplest interface.

PHASE II: Implement the best approach resulting from the documented reports in Phase I. Deliverable includes interface control document and prototype software that will be tested at CERDEC. Deliverable final report will include the final design, as well as test results, and any results of modeling and simulation. The prototype must demonstrate how it interfaces with all network management tools. It must also demonstrate how it dynamically determines data with high entropy.

PHASE III: Complete the development of the prototype described in Phase II and refine to the degree necessary to transition into a program. Some potential programs this capability could transition to include the JTRS NMS, Future Combat System NMS, and WIN-T NMS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Future commercial wireless networks will be ad hoc networks and therefore will be limited in bandwidth resource. Hence, they will also be required optimize data streams based on entropy. By researching them now and building a prototype software solution the commercial world would have tools to best utilize bandwidth.

REFERENCES:
1. Lakshminath Bhuvanagiri, Sumit Ganguly, Estimating Entropy over Data Streams, http://icdcit.org/users/sganguly/ent.pdf

2. M A.Wagner and B Plattner. “Entropy based worm and anomaly detection in fast IP networks. In 14th IEEE WET ICE, STCA Security Workshop, 2005

KEYWORDS: Entropy; Interface; Bandwidth; Optimization; Transport; JTRS

N093-220 TITLE: Ultra Low PIM Diplexer

TECHNOLOGY AREAS: Electronics, Space Platforms

ACQUISITION PROGRAM: Mobile User Objective System (MUOS), an ACAT I program.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Improve the passive inter-modulation (PIM) performance of diplexers for future communications satellites.

DESCRIPTION: Intermodulation or intermodulation distortion is the result of two or more signals being mixed together to form additional frequencies that are not desired. Intermodulation occurs in non-linear systems, which generally have active components that require a power source in addition to the input signal. Passive intermodulation (PIM) can occur in components with junctions of dissimilar metals or metals and oxides. The junctions effectively form diodes, which are non-linear. This leads to intermodulation in systems designs where there should theoretically be none.

Since the use of nonlinear materials is usually prohibited in the transmit signal path of a diplexer, typically the major source of nonlinearities is imperfect metal-to-metal contacts associated with the assembly of the diplexer from multiple metal parts. These imperfect contacts can occur due to workmanship issues such as flatness tolerance or insufficient contact pressure, and are also typically related to thermal issues such as expansion and contraction at these interfaces. Diagnosing and attempting to correct such microscopic workmanship problems is typically extremely difficult and time consuming, and can be futile given the usual schedule pressures.

Since PIM is a nonlinear phenomenon that depends on the transmit signal levels and the order of interest, one can"t define "ultra-low PIM" by specifying a single power level. Probably the simplest way to quantify "ultra-low PIM" is to provide an example, i.e., the Mobile User Objective System (MUOS) diplexer. The current 7th-order PIM specification (which assumes two simultaneous 400 W transmit signals) for the MUOS diplexer is -113 dBm. A beyond state-of-the-art improvement in diplexers will enable a significant increase in system capability. A level of -130 dBm or lower for this particular transmit signal level and PIM order could be considered very good PIM performance. It is believed that a level significantly below -130 dBm is achievable, and this could therefore be considered "ultra-low PIM" for this application.

Since the achievable PIM performance of a diplexer is typically limited by workmanship issues, a new manufacturing process, new materials, or a new design philosophy that minimizes the effects of workmanship issues, would be very beneficial.

PHASE I: Develop a new manufacturing process, new materials, or a new design philosophy that minimizes the effects of workmanship issues on the PIM performance of diplexers.

Tasks under this phase could include:
- Develop a new manufacturing process, new materials, or a new design philosophy
- Develop a model to show the expected PIM performance of the proposed solution
- Describe trade-offs to be explored in Phase 2

PHASE II: Develop a prototype diplexer and demonstrate its performance against expectations.
- Refine the design and develop a prototype(s) based on Phase I efforts.
- Evaluate measured performance characteristics versus expectations and make design adjustments as necessary.

PHASE III: This phase will focus on manufacturing the diplexers for MUOS or follow on satellite systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL DUAL-USE APPLICATIONS: This technology can be applied to any system using diplexers, including satellite communications and terrestrial wireless communications.

REFERENCES:
1. “Passive intermodulation interference in communication systems”, Lui, P.L., Electronics & Communication Engineering Journal, Volume 2, Issue 3, Jun 1990 Page(s):109 - 118

2. “Surface Treatment and Coating for the Reduction of Multipactor and Passive Intermodulation (PIM) Effects in RF Components,” D. Wolk, J. Damaschke, C. Vicente, B. Mottet, H.L. Hartnagel, L. Galán, I. Montero, E. Roman, M. Alfonseca, J. de Lara, D. Raboso

3. “Systems Methodology for PIM Mitigation of Communications Satellites,” 2003, Rabindra (Rob) Singh, Eric Hunsaker,

4. International workshop in Multipactor, Corona and Passive Intermodulation (MULCOPIM) 2008, http://www.cfp.upv.es/mulcopim08/cd_interior_mulcopim/inicio/index.html

KEYWORDS: MUOS; PIM; passive intermodulation; diplexer; SATCOM

N093-221 TITLE: Highly Efficient Transmitter for High Peak to Average Power Ratio (PAPR) Waveforms

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: Joint Program Executive Office Joint Tactical Radio System, ACAT I

OBJECTIVE: Develop a compact highly efficient transmitter for complex waveforms and other waveforms with a high Peak to Average Power Ratio (PAPR)

DESCRIPTION: Modern military and most commercial waveforms utilize complex non-constant envelope waveforms incorporating Orthogonal Frequency Division Multiplexing (OFDM) modulation schemes. This adds significant challenges to transmitter efficiency and signal fidelity. It is well known that Class E amplifiers are highly efficient for constant envelope waveforms. However, it has proven difficult to amplitude modulate a Class E amplifier while maintaining reasonable efficiency and signal fidelity.

The desired innovation is a transmitter that employs highly efficient class E operation for both constant and non-constant envelope waveforms, while maintaining signal fidelity. To avoid redundancy, a single transmitter device should be capable of modulation of commercial waveforms such as GSM, WiMAX and LTE, military waveforms such as SRW, and should have the ability to switch from one waveform to another seamlessly. It should also be capable of OFDM modulation of military waveforms. The transmitter should handle the entire analog and RF processing burden, and should have digital I and Q and frequency as inputs.

The transmitter should be capable of transmitting over a wide carrier frequency range, and should be capable of output power up to 40dBm. It should have the capability of up to 20MHz Carrier Bandwidth at 1 GHz carrier frequency.

PHASE I: Conduct a study to determine the feasibility of a transmitter that can simultaneously provide:
- Employment of Class E operation for constant and non-constant envelope waveforms
- High Efficiency and Signal Fidelity for High PAPR waveforms
- Broad Carrier Band Operation (~1-2 octaves at 1GHz)
- Provide up to 40dBm power output

PHASE II: Develop Proof of Concept board or boards that demonstrate:
- Employment of Class E operation for constant and non-constant envelope waveforms
- High Efficiency and Signal Fidelity for High PAPR waveforms
- Broad Carrier Band Operation (~1-2 octaves at 1GHz)
- Provide up to 40dBm power output

PHASE III: Develop a Broad Carrier Band transmitter capable of simultaneously providing:
- Employment of Class E operation for constant and non-constant envelope waveforms
- High Efficiency and Signal Fidelity for High PAPR waveforms
- Broad Carrier Band Operation 30MHz – 6GHz
- Up to 40dBm power output
- 20MHz bandwidth at higher frequencies (i.e. 1GHz and higher)

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Significant commercial applications for this technology are anticipated for use in telecommunications applications (i.e. Pico cells, Femto cells, and other Wide Area Network Communication Devices)

REFERENCES:
1. http://www.ee.ucl.ac.uk/lcs/prog01/LCS077.pdf

2. http://www.waset.org/pwaset/v33/v33-51.pdf

KEYWORDS: Transmitter; Class E amplifier, OFDM, waveforms, efficiency, Peak to Average Power Ratio

N093-222 TITLE: Memristor Implementation in Software Defined Radio Hardware Architecture

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

ACQUISITION PROGRAM: JPEO JTRS, Ground Mobile Radio, ACAT I

OBJECTIVE: Investigate and validate areas of hardware component improvements within a generic Software Defined Radio Hardware Architecture surround the use of Memristor componets.

DESCRIPTION: In a 1971 paper, Leon Chua, a professor of electrical engineering at the University of California, Berkeley, predicted the existence of a fourth fundamental device, which he called a memristor. He proved that memristor behavior could not be duplicated by any circuit built using only the other three passive circuit elements (resistor, capacitor, and inductor), which is why the memristor is truly fundamental. In May 2008, Hewlett-Packard Labs in Palo Alto, CA published in Nature magazine that they had finally managed to build the device. R. Stanley Williams and Greg Snider published a paper in 2008 showing that memristors could vastly improve a field-programmable gate array. Memristors are easy to fabricate, the limitation to manufacturing hybrid chips with memristors is that only a small number of people have any idea of how to design circuits containing memristors. The goal of this effort is to determine what hardware components within a generic SDR architecture would benefit from the implementation of memristors within the circuits design and quantify the benefit.

PHASE I: Identify hardware components within a generic SDR hardware architecture that could be improved using memristors. Quantify the improvements by orders of magnitude. Provide a paper documenting the present state of the art, the approach and results.

PHASE II: Build and test prototype of circuit chosen from the results of Phase I.

PHASE III: Incorporate circuit from PHASE II in future JTRS SDRs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Homeland Security initiatives are driving municipal, county, state, and federal agencies to obtain an interoperable communications capability. Software Defined Radio and digital communications approaches are emerging as the next-generation solution to robust interoperability. The technology developed from this topic is directly applicable to these non-DOD interoperable communications applications.

REFERENCES:
1. R. Stanley Williams, HOW WE FOUND THE MISSING MEMRISTOR, IEEE Spectrum, DEC 2008.

2. Dmitri B. Strukov, Gregory S. Snider, Duncan R. Stewart & R. Stanley Williams, THE MISSING MEMRISTOR FOUND, Nature 453, 80-83 (1 May 2008).

3. Chua, Leon O. “Memristor – The Missing Circuit Element”. IEEE Transactions on Circuits Theory (IEEE) 18 (5): 507–519. (September 1971).

KEYWORDS: RF components, microelectronics, electronic materials; JTRS

N093-223 TITLE: Low Cost Orbital Debris Removal System

TECHNOLOGY AREAS: Space Platforms

ACQUISITION PROGRAM: Mobile User Objective System (MUOS), an ACAT I program.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a cost effective system design to remove high payoff orbital debris from medium and high Earth orbits. Build a prototype and demonstrate it in the space environment.

DESCRIPTION: Recent events have exasperated the growing problem that orbital debris, or “space junk,” poses to spacecraft. The Chinese anti-satellite weapons test in 2007 destroyed the ailing Fengyun-1C weather satellite, creating over 2,300 pieces of debris. The February 2009 collision between Russia's Cosmos 2251 and a commercial Iridium satellite also created a cloud of hundreds of pieces of debris. Orbital debris poses increasing risk to multi-billion dollar space systems and must be mitigated.

Efforts to address orbital debris have primarily focused on preventing the future creation of space junk or removal of junk in Low Earth Orbit (LEO). Some options have examined increasing atmospheric drag to accelerate orbit decay, which appears to be effective approach only at LEO. Many critical military and commercial satellite systems operate in higher orbits and will not be helped by such systems. Affordable system concepts to remove orbital debris from mid to high Earth orbits are needed.

Launching any debris removal system into a mid or high Earth orbit will be expensive so debris removal efforts must be focused on high pay off items. Rocket upper stages and other items in orbit suspected to have non empty fuel tanks often end up exploding years after their useful on-orbit life has ended. When these fuel tank related items explode they create clouds of orbital debris. Candidate solutions should target these items. Once the technology is proven for these items perhaps it can be applied in other cases.

The debris removal system must be simple but effective. Since the time for removal is not critical, removal systems could be attached to the debris and slowly de-orbit the debris. A cost goal for the de-orbiting system is less than $50K, not including launch costs.

PHASE I: Develop a cost effective system design to remove high payoff orbital debris from medium and high Earth orbits.

Tasks under this phase could include:
- Design a low cost orbital debris removal system
- Predict system performance using modeling and simulation or other tools
- Estimate launch mass and volume requirements.

PHASE II: Build a prototype debris removal system
- Optimize the system design
- Demonstrate operation of the prototype in a space environment such as thermal vacuum.

PHASE III: Depending on available launch opportunities, demonstrate the prototype in space on a target similar to the high pay off items discussed above. The chosen target should not contain fuel or explosive components likely to create a debris cloud in the case of a mishap.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Space is increasingly used for commercial purposes. Commercial satellite operators could use this technology to ensure the area near their spacecraft is free of debris to avoid potential collisions. Satellite insurance companies may also use such a service to reduce risk.

REFERENCES:

1. "Advanced Space System Concepts and Technologies" Ivan Bekey, The Aerospace Press, El Segundo, CA, 2002, pages 33-38 and 190-191.

2. "Orion's Laser: Hunting Space Debris" Ivan Bekey, May 1997 , Aerospace America, Vol 35, No 5, pp 38-44.

3. NASA Orbital Debris Program Office, http://orbitaldebris.jsc.nasa.gov

KEYWORDS: MUOS; orbital debris; MEO; LEO

~~N093-224 TITLE: Forward Observer Automated Target Detection and Acquisition Software~~

~~TECHNOLOGY AREAS: Information Systems, Battlespace~~

~~ACQUISITION PROGRAM: JPEO JTRS ACAT 1D~~

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~~OBJECTIVE: Develop a handheld automated target acquisition and intelligence collection system.~~

~~DESCRIPTION: U. S. Army (USA), U. S. Marine (USMC), and Special Operations Force (SOF) units encountering individuals, vehicles, or sites suspected of being hostile are responsible to locate them with the accuracy necessary for precise delivery of artillery or Close Air Support (CAS) if warranted, report them quickly enough to enable appropriate action, and provide authorities with information useful in their identification to avoid engaging or inflicting collateral damage on coalition forces or neutral populations. The proposed system requires development of specialized software (SW). This SW will enable USA, USMC, or SOF Forward Observers (FOs) to laser range on and photograph potential targets with modified binoculars, identify adjacent radios from JTRS Enterprise Network to range on the same potential targets and report, then integrate the military Global Positioning System (GPS) locations provided by JTRS radios and the range arcs intersecting at the potential target to yield a more precise potential target location than would be available from a single designator with inherent magnetic azimuth inaccuracies. The SW would then incorporate the potential target location in standard format Call for Fire (CFF) or request for CAS text messages with predetermined FO identification and recipient addresses, e.g. Fire Direction Center (FDC), direct support battery, Tactical Operations Center (TOC), and default fire control data, e.g. proximity fusing, attach a potential target photograph, and transmit these messages immediately; eliminating delays imposed by voice transmissions and read backs and obviating the need for FO authentication since JTRS networks are inherently secure. Development of modifications to the SW used at FDCs, artillery batteries, and TOCs would enable decision makers to verify the appearance of the target based on the photograph submitted by the FO and run the potential target grid through the Enhanced Position Location and Reporting System (EPLRS), Force XXI Battlefield Command Brigade and Below (FBCB2), Blue Force Tracker (BFT), follow-on Unified Battle Command (UBC) system, and/or Global Command and Control System - Army / Maritime (GSSC-A/GCCS-M) as appropriate to determine whether ordnance can be delivered per Rules of Engagement (ROE) without endangering friendly or neutral entities. The system would be useful in intelligence collection even if potential targets are not engaged. If targets are engaged, the system could provide rapid damage assessment to evaluators. The focus of the SBIR is on SW development leveraging existing or planned components to operate within space, weight, and power (SWP) constraints of operating forces, be interoperable with command, control, and communications (C3) SW, and not materially increase acquisition costs.~~

PHASE I: Define functional phases of the targeting & grid clearance process with optional capabilities such as infra-red optics, laser target designation, and automated target grid safety clearance. Conduct SW development & R&D with surrogate components to verify SW support of functional phases target location leveraging GPS accuracy of networked radios, automated messaging to request artillery and/or close air support, and intelligence collection.

PHASE II: Demonstrate automated targeting, supporting arms requests, and intelligence collection in field conditions within several common operational scenarios. This phase will include development of hardware. A completely functional prototype is not required; however, the feasibility and the expected performance of a fully operational automated target acquisition and intelligence collection system should be clearly evident within the demonstration.

PHASE III: Development of a deployable unit and supporting data and decision support systems to enable integration with existing C4ISR and systems used for location of friendly forces such as GCCS-A/M and Blue Force Tracker. A successful Automated Target Acquisition and Intelligence Collection has the potential significantly reduce the time from threat detection to ordnance on target and thereby enhance the lethality and survivability of US forces.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATION: The Automated Target Acquisition and Intelligence Collection System has potential use with the Department of Homeland Security, US Customs, US Border Patrol, Law Enforcement, and Intelligence Agencies for the collection and transmission of data on personnel, vehicles, and sites of interest. The US Coast Guard may have maritime identification and location requirements similar to US Navy use. The system also has potential use in Search and Rescue operations for rapid transmission of position and visual data of rescue victims or identification of potential hazards.

REFERENCES:

1. Sample binocular: http://www.opticsale.com/newcon-optik-laser-rangefinder-7x25-lrm2000pro-2000yard-measuring-range-speed-detector-compass-monoc.html

2. JTRS overview: http://jpeojtrs.mil/

KEYWORDS: Software; Radio; Binoculars; Targeting; Communications; Identification; Photography; Artillery; Aircraft

N093-225 TITLE: Cross-layer Queue Management and Queue-status Messages for Wireless Tactical Networks

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: JPEO JTRS, Network Enterprise Domain (NED), ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a strategy suitable for tactical wireless networks that off-loads TCP/IP traffic to temporary storage or alternate pathways rather than simply dropping packets from overflowing queues. In particular, a cross-layer queue management and retransmission approach is of interest.

DESCRIPTION: Tactical networking radios, particularly those integrated into Mobile Ad Hoc Networks (MANET) have the complex task of retransmitting data from adjoining nodes as well as transmitting “fresh” data from its native user. The network management task is further complicated by the use of encrypted data packets (e.g., “black-core routing”). In military tactical networking applications, all users operate at peak demand simultaneously due to the need to engage a threat or target – this is a very different data load rate scenario than a conventional office or commercial wireless network.

The rate at which data queues are emptied is a function of the instantaneous throughput available and the traffic precedence. When demand exceeds capacity, packets begin being dropped as the queues fill up. A cross-layer queue management strategy would likely possess the following attributes:
- Sense queue status and estimate if overflow condition is developing
- Ability to re-route packets to an external buffer
- Ability to report queue and available capacity status to applications and the user
- An application for management of the external queue device

PHASE I: Develop a cross-layer queue management approach to optimize data throughout on wireless networks with data loading statistics representative of military tactical operations. Prove the viability of the concept using modeling and simulation.

PHASE II: Create a more comprehensive software implementation suitable for development and capability demonstration using software-defined radios development platforms. Demonstrate the performance of the proposed approach. In order to demonstrate practical viability, estimate the digital processing requirements and software code size required to port and adapt the software to available Software Defined Radio platforms.

PHASE III: Enhance and port the software into the JTRS radio product lines. Support development and operational testing processes by users. Maintain and enhance capabilities of software to meet JTRS Enterprise requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed in this project is directly applicable to any wireless network such as WiFi, WiMax, or emerging emergency services and Homeland Security radio systems.

REFERENCES:
1. Software Communications Architecture, JTRS Standards, JPEO JTRS, http://sca.jpeojtrs.mil/

2. S. Ohzahata, S. Kimura, et al, "A Cross-Layer Retransmission Control for Improving TCP Performance in Wireless LAN," IEICE Transactions on Communications 2007 E90-B(8):2070-2080, http://ietcom.oxfordjournals.org/cgi/content/abstract/E90-B/8/2070?ck=nck

3. E. Hossain and D. Niyato, "A Novel Analytical Framework for Integrated Cross-Layer Study of Call-Level and Packet-Level QoS in Wireless Mobile Multimedia Networks," IEEE Transactions on Mobile Computing, Volume 6, Issue 3 (March 2007), pages 322-335, http://portal.acm.org/citation.cfm?id=1263136.1263377&coll=GUIDE&dl=GUIDE&CFID=26164483&CFTOKEN=95471939

KEYWORDS: cross-layer, queue, retransmission, MANET, wireless, JTRS

N093-226 TITLE: <u>New Materials/Process for Space Qualified Electronic Components</u>

TECHNOLOGY AREAS: Electronics, Space Platforms

ACQUISITION PROGRAM: Mobile User Objective System (MUOS), an ACAT I program.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a new design or manufacturing process to quickly produce electronic components that are reliable in the space environment.

DESCRIPTION: Space is a harsh environment. Spacecraft are subjected to high levels of radiation depending on the orbit. Spacecraft undergo extreme thermal cycles as they move in and out of direct sunlight. Temperatures range from -171C to 108C at geosynchronous orbit.

The electronics on spacecraft must be able to withstand the space environment to assure mission success. However, the aerospace industry orders relatively low quantities of “space qualified” electrical components, often at irregular intervals. This makes it a difficult business case for companies to keep a manufacturing line open just for space components. This leads space programs to rely on a very small number of suppliers, sometimes even a single source, which is highly undesirable.

New electronic component designs or manufacturing processes are needed to address this problem. If manufacturers could quickly and easily transition from producing mainstream items to space qualified components, competition would increase. Increased competition will reduce space program costs and improve availability and reliability of components.

Although desirable, a single process for multiple types of components is unlikely. Therefore, this topic will focus on resistors, specifically the RNC-70 class of resistors described by MIL-PRF-55182/6P. The resistors must be able to withstand greater than 8,000 thermal cycles of extremes as described above and continue to meet the standard.

PHASE I: Develop a new design or manufacturing process to quickly produce resistors that are reliable in the space environment.

Tasks under this phase could include:
- Apply new materials breakthroughs
- Develop a new design or manufacturing process for space qualified resistors
- Develop a process model
- Predict process yield and estimate the cost to implement it

PHASE II: Implement the new materials, design or process, and demonstrate its performance against expectations.
- Implement a new material
- Implement the new design or process
- Evaluate measured performance characteristics versus expectations and make design/process adjustments as necessary.

PHASE III: This phase will focus on manufacturing components required for Navy satellite systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology can be applied to any space system, including space exploration, commercial communications, and imaging satellites.

REFERENCES:
1. MIL-PRF-55182/6P, http://assist.daps.dla.mil/quicksearch

KEYWORDS: Space-hardened resistors; space qualified resistors; pre-qualified space electronic parts

N093-227 TITLE: Automated Analysis and Verification of Application Program Interfaces (APIs)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Program Executive Office Joint Tactical Radio System, ACAT ID

OBJECTIVE: Develop an approach that supports an automated solution in verifying a set of standard Application Program Interfaces with developer source code. The approach must increase objectivity and efficiency of the verification of these Standard APIs through repeatable processes. The approach must also provide adequate flexibility to enable usage of this product in commercial and military applications.

DESCRIPTION: Application Program Interfaces (APIs) are software-level interface standards between software modules or software/hardware segments that enable software developers to write code that can be interfaced with the code written by others when integrated into a complete system. The compliance of individual software modules with the API specification is critical in order to create a maintainable software system over the long-term. Even small shortfalls in API compliance can result in the need for extensive software code rework at a high cost of dollars and schedule. Since large software projects are usually comprised of several teams of developers working in diverse locations, the impact of integration cost to the total effort is critical. This integration process could be greatly accelerated if a tool were available that could automatically inspect software modules for API compliance.

The JTRS family of Software-Defined Radios (SDRs) are being deployed with waveform application software specifically developed to a specific set of standard APIs that are common among the JTRS radio platforms. This approach enables reuse of software across multiple radio platforms with minimal rewrite. However, in practice much of the software delivered by vendors is only partially compliant. The analysis of the code by government engineers and subsequent rework by vendors are expensive processes, and an automatic means of performing API verification would result in significant reduction in software development and maintenance costs.

A suitable software tool cannot perform this operation simply by comparing text or following an inflexible set of "rules." Rather, the tools must to be able to compare the source code input to the API specification and determine compliance – without the need for the user to program the tool by explicitly defining all acceptable implementations. The tool needs to be "smart" enough to accurately interpret the source code and minimize the number of false positives and negatives. In addition, the technical approach for this tool must be able to accommodate source code that is composed of either hundreds or millions of lines.

PHASE I: Develop an approach and architecture that can automatically verify that software products meet a specified set of APIs. Develop a prototype that successfully demonstrates the concept, its role within the overall verification process, and generates analysis reports based upon the errors found during the verification process.

PHASE II: Develop the concepts demonstrated in Phase I into a fully-functional software "beta version" prototype tool. This tool should include a graphical user interface, enable the user to select API specification and developer source code files, , enable the user to specify the errors that should be checked and reported, and generates an analysis report in a format that aids the user in resolving identified shortfalls. The tool should be hosted on an industry-standard platform using an industry-standard software development environment.

PHASE III: Complete development of the tool to enable use with source code exceeding millions of lines. To test and validate the product, support rigorous testing of the software's functionality performed by the JTRS Test and Evaluation Laboratory (JTEL). Transition the beta software of Phase II into a supportable commercial product that meets industry best-practices for stability, user interface design, and support for industry-standard platforms/operating systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Software defined radios and other wireless communications devices being sold for commercial and consumer use, such as the Apple iPhone, Microsoft Windows Mobile, and Google Android platforms, are capable of downloading and running applications written by a vast community of software developers. The techniques developed for this project could be implemented into the Software Development Kits (SDKs) used to develop software for these devices. The same benefits in software development and maintenance costs apply.

REFERENCES:

1. Software Communications Architecture (SCA) Version 2.2.2, 15 May 2006, http://jtrs.spawar.navy.mil/sca/

2. Stephens, D.R., Salisbury, B., Richardson, K., "JTRS Infrastructure Architecture and Standards", MILCOM 2006, Washington, D.C.

3. JTRS Infrastructure Architecture, Version 1.0, 22 December 2006.

KEYWORDS: API; verification; source code analysis; syntax checking; software; IDL comparison.