NAVY
SBIR FY10.1 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 **10 December 2009.** Beginning 10 December, 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
N101-001 thru N101-003	Mr. Paul Lambert	MARCOR	sbir.admin@usmc.mil
N101-004 thru N101-042	Mrs. Janet McGovern	NAVAIR	navair.sbir@navy.mil
N101-043 thru N101-069	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N101-070 thru N101-071	Mr. Nick Olah	NAVFAC	nick.olah@navy.mil
N101-072	Mr. John Gallagher	NAVSUP	john.gallagher@navy.mil
N101-073 thru N101-074	Mr. John Kieffer	NSMA	john.f.kieffer@navy.mil
N101-075 thru N101-098	Mrs. Tracy Frost	ONR	tracy.frost1@navy.mil
N101-099 thru N101-105	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 and NAVSEA topics N101-004 thru N101-069 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 (PL 111-84, PL102-564, PL111-10, PL111-43 and PL 111-66) 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 111-84, Public Law 106-554, Public Law 111-10, Public Law 111-43, PL 111-66 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 <u>must be met</u> or your proposal will be REJECTED.

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

____2. Your technical proposal has been uploaded and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 am ET, 13 January 2010.

____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 and NAVSEA topics N101-004 thru N101-069, 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.

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~~N101-084~~	~~Strained Layer Superlattice (SLS) Dual Band Focal Plane Array (FPA)~~
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N101-099	Spectrum Agile Network Distributed Subcarrier Allocation
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NAVY SBIR 10.1 Topic Descriptions

N101-001 TITLE: Mitigation of Blast Injuries through Modeling and Simulation

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

ACQUISITION PROGRAM: PEO-LS ACAT II

OBJECTIVE: The objective of this topic is to investigate the effect of non-centerline IED/mine blast on crew survivability and to develop a physics-based model that will assist in the design of safety components devised to mitigate injuries sustained by individuals riding in tactical wheeled vehicles.

DESCRIPTION: Military personnel riding in tactical wheeled vehicles, such as the Mine Resistant Ambush Protected (MRAP) family of vehicles and the Medium Tactical Vehicle Replacement (MTVR) vehicle, continue to suffer from both death and serious bodily injury as a result of IED/mine explosions. In almost all cases, the event is from an encounter with a non-centerline IED/mine, generating a significantly complex blast load on the vehicle, seats, restraints, and ultimately the crew. Design and development of safety components to mitigate these crew injuries requires a physics-based model able to account for both soil/structure interaction and gross vehicle response. Using the model developed, vehicle response and resulting load profiles on crew members will be generated and used to identify/select designs that enhance crew safety and mitigate injuries. Existing engineering based personnel survivability models will then be used to verify the effectiveness of these newly designed safety components. This modeling and simulation activity will provide a capability that does not exist, providing an evaluation and validation tool to design safety components that save lives.

PHASE I: The contractor will research the numbers, types, and severity of injuries sustained by military personnel embarked in MRAP, MTVR, and other vehicles. The contractor will develop the characteristics of these vehicles as well as the damage sustained from the IED/mine blast at the specified encounter geometry. The contractor will also select the basic modeling approach and algorithms from which the model will be developed. The preliminary model will be used to perform simulations against a particular threat type, size, and location and predictions analyzed using existing live fire test data such as floor, seat, wall, and roof accelerations.

PHASE II: The contractor will continue to refine the efforts initiated in Phase I. The contractor will develop and demonstrate the models' ability to couple the vehicle-crew response to specific body regions of crew members, such as legs and head. Super Hybrid III Anthropomorphic Test Devices (ATDs) data will be used to verify model predictions. The contractor will also establish a model requirements standards document that will provide sufficient guidance to engineers as to the geometry and material property data required to run the code. The contractor will add the capability to the model initial mitigation design approaches such as padding, seating designs, and restraint systems.

PHASE III: The contractor will cooperate with MRAP, MTVR, and other tactical vehicle manufacturers, including commercial industry vendors, to obtain test data from vehicles utilizing new safety features or components. This data will be used to verify the models predicted reduction in crew injury and focus designers on the best areas for improvement. The contractor will continue to use the model to recommend additional potential design changes that enhance crew safety and reduce injuries.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Reduction of injuries resulting from vehicle crash and rollover.

REFERENCES:
1. M. J. Chinni (Ed.), Proceedings of the 1997 Simulation MultiConference: Military, Government, and Aerospace Simulation (April 6-10, 1997). Simulation Series 29(4), 217-222. San Diego, CA: The Society for Computer Simulation International.

2. Upton, G. F. & Holmes, B. (1999). Challenges and solutions in developing a dynamic terrain enabled PC-based software image generator. In, Proceedings of the Interservice/Industry Training Systems and Education Conference, pp. 749-757.

KEYWORDS: MRAP; blast protection; vehicle rollover; leg injury; vehicle restraint devices; modeling and simulation

N101-002 TITLE: Modular Lightweight Armor System

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: The Program Manager Advanced Amphibious Assault (PM AAA) ACAT-I

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Research, develop and build a lightweight modular armor package.

DESCRIPTION: The Marine Corps EFV is a 78,200 lb. armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. The EFV design is limited due to competing requirements: 1) high water speed, 2) combat effectiveness and carrying capacity, and 3) survivability. The current armor system meets functional requirements, weight however is critical to an amphibious vehicle therefore a lighter solution (1 to 2 lb. per sqr. ft.) while maintaining or improving the current ballistic protection levels (14.5 mm AP @ 300 meters) is desired. The armor system should be applicable but not limited to the vehicle skirt. The selected armor system(s) must demonstrate the ability to function in extreme operating environments which include but are not limited to -25°F to +120°F, hot desert blowing sand, full salt water immersion and immersion in petroleum based liquids. The armor system must be able to be integrated into the existing EFV design.

PHASE I: The contractor shall conduct research into lightweight modular armor systems for use on the EFV, keeping in mind the environment in which those materials will be used. Based on their research, the contractor shall create a conceptual design including estimated weight, cost and performance characteristics.

PHASE II: The contractor shall manufacture a prototype armor panel(s) and conduct ballistic testing to validate their design meets EFV specified performance levels and characterize the performance. Due to the nature of this topic, the contractor must be ready to shift into a classified performance mode with cleared personnel and storage available.

PHASE III: The preferred transition is to contract with the prime vendor (General Dynamics Land Systems) to integrate the system onto the EFV. This technology is also directly applicable to large military vehicles such as the Army's FCS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development and characterization of lightweight modular armor systems has direct application to a wide verity of protective requirements for uses in various military and commercial land and sea based vehicles. This technology is also applicable to the protection of structures.

REFERENCES:
1. EFV S/SS Specification Rev N. dated 23 June, 2008 (available upon request)

2. MIL-STD-810F Environmental Test Methods and Engineering Guidelines

3. MIL-STD-889B Dissimilar Metals

4. MIL-STD-662F V50 Ballistic Test For Armor

5. AR 70-75 Survivability of Army Personnel and Materials

6. STANAG 4569

KEYWORDS: Ballistic; Materials; Ballistic Protection; Lightweight; Armor; Survivability

N101-003 TITLE: Lightweight High Temperature Armor

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: Program Manager Advanced Amphibious Assault (PM AAA) ACAT-I

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OBJECTIVE: Provide high temperature (up to 500º F) ballistic protection in areas exposed to high temperatures, such as an engine compartment roof, while meeting the weight limitations for light weight armored vehicle.

DESCRIPTION: For example, the Marine Corps EFV is a 78,200 lb. armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. There are several areas of the vehicle where temperatures can exceed 500º F in the event of an exhaust failure. The current configuration is rated at 250° F without degradation in ballistic performance against 20mm FSP (Fragment Simulating Projectiles). It is desired to increase the temperature tolerance of the composite material to compensate for possible exhaust gas exposure without degradation in ballistic performance. Materials should not produce toxic fumes, smoke or flame when exposed to high temperatures. The selected material(s) must demonstrate the ability to function in operating environments which include but are not limited to -25° F, hot desert blowing sand, full salt water immersion and immersion in petroleum based liquids. The composite must be able to be integrated into existing armor designs.

PHASE I: The contractor shall conduct research into composite materials that do not degrade from exposure to a temperature of 500º F for an extended period for use in engine compartments, keeping in mind the environment in which those materials will be used. Based on their research, the contractor shall create a conceptual design including estimated weight, cost and performance characteristics.

PHASE II: The contractor shall manufacture a prototype armor panel(s) and conduct ballistic testing to validate their design meets specified performance levels.

PHASE III: Contract with the prime vendor (General Dynamics Land Systems) to integrate the material onto the EFV. Contract with any vendor to integrate the material onto armored vehicles. This technology is directly applicable to any military vehicle.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This material could be applied in any application involving protection from high heat and flame such as building materials. Retrofit on existing US combat systems.

REFERENCES:
1. EFV S/SS Specification Rev N. dated 23 June, 2008 (available upon request)

2. MIL-STD-810F Environmental Test Methods and Engineering Guidelines

3. MIL-STD-889B Dissimilar Metals

4. MIL-STD-662F V50 Ballistic Test For Armor

4. AR 70-75 Survivability of Army Personnel and Materials

5. STANAG 4569

KEYWORDS: Lightweight; Armor; High Temperature; Ballistic Protection; Survivability; Materials

N101-004 TITLE: Air Anti-Submarine Warfare Modeling and Simulation Tool

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-264, High Altitude ASW, PMA-290, Maritime Patrol and Reconnaissance

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a stochastic simulation that evaluates all phases of the Air Anti-Submarine Warfare (ASW) mission, at engagement-level fidelity.

DESCRIPTION: An Air ASW few-vs-few simulation would provide NAVAIR with a unique capability to perform Air ASW analysis acceptable to programs and meaningful to war fighters. There are many tools and simulations that examine specific parts of the Air ASW mission, such as radar periscope detection, multi-static active acoustics, and passive acoustics. There are also several tools that examine systems or systems of systems and the mission or campaign level. What is lacking is a model that evaluates the entire Air ASW mission, from detection through localization through weapon drop, to an appropriate degree of fidelity to quantify the operational effectiveness of Air ASW systems. Typically mission and campaign-level simulations are capable of evaluating across a broad spectrum of missions and platforms, providing quantitative data for "what it takes to win" measures of effectiveness. These tools traditionally do not possess the fidelity to quantify the value of individual sensors or weapons, or other factors such as velocity, flight profile, buoy patterns, etc. The problem to be solved is to develop a stochastic simulation that bridges the gap between engineering-level models and mission and campaign-level models and allows for a high-fidelity, quantitative assessment of various piece of the entire Air ASW mission.

This simulation should consider advanced mathematical modeling and operations research techniques to appropriately represent current and future aspects of search theory, area of uncertainty expansion, environmental factors, data fusion, acoustic and nonacoustic sensors, and aircraft motion characteristics. The model should represent the complex Air ASW mission at a high level of detail through dissimilar systems and environments. Resulting analyses, from the tool, would demonstrate the utility of airborne ASW system capabilities and upgrades in the operational context of integrated systems and cooperative tactics and counter-tactics fully informed by representations of enabling factors such as communications, Intelligence, Surveillance, and Reconnaissance (ISR), and Command and Control (C2). The results of this type of tool could also credibly inform and calibrate more aggregate mission- and campaign-level tools with the full force of their context. Design of experiments, metamodeling and simulation federation techniques should be considered in order to determine an optimal approach to integrating with mission and campaign tools.

PHASE I: Develop and demonstrate initial concept of modeling algorithms incorporating search theory and mathematical modeling techniques.

PHASE II: Fully develop, finalize and validate algorithms. Develop prototype simulation tool and demonstrate analysis capabilities.

PHASE III: Conduct testing verification and validation. Transition tool to end-user.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The necessary human behavior and search theory algorithms are applicable to various types of unmanned surveillance, particularly subsurface unmanned surveillance. Undersea search vehicles are used for commercial shipping, oil industry, and environmental and oceanographic companies. This tool can be used to provide analysis on the optimal search patterns for vehicles and enable the development of algorithms to allow for greater levels of autonomy and self vectoring.

REFERENCES:
1. Law and Kelton, “Simulation Modeling and Analysis,” 2000.

2. Navy Modeling and Simulation Office website; https://nmso.navy.mil/VVA/tabid/58/Default.aspx/

3. Carl, R. Greg, Champagne, L., Hill, Raymond, “Search Theory, Agent Based Simulation, and U-Boats in the Bay of Biscay,” Proceedings of the 2003 Winter Simulation Conference; (http://ormstomorrow.informs.org/archive/spring03/Submissions/carl_paper.pdf)

4. Milan, V. “On Naval Power,” Joint Force Quarterly, Issue 50, 3rd Quarter 2008, pg 8.

5. Concept of Operation for the 21st Century Task Force ASW; http://www.navy.mil/navydata/policy/asw/asw-conops.pdf

KEYWORDS: Air Anti-Submarine Warfare; Modeling and Simulation; Mathematical Modeling; Operations Research; Search Theory; Stochastic Simulation

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-005 TITLE: Spread Spectrum Techniques for Sonar Ping Technology

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: ACAT IV, PMA-264, Air ASW Systems; Sea Shield

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a generic sonar system consisting of sonar source that can covertly perform an active search while also being compatible with marine life.

DESCRIPTION: Distributed or multistatic active sonar systems have the ability to detect, classify and localize targets in large areas of the search field. One major drawback of the active (ping) energy can more readily alarm the submerged target than detect it. The current active ping can also be detrimental to humans swimming, as well as marine mammal life that can suffer long-term physical impairment. A new approach is required that can realistically provide active sonar detection with ensonification energy that is less detectable to frequency swept sonar intercept receivers but whose target resonified energy can be easily ‘seen’ by the properly ciphered sonar receivers. Improved signal to noise ratio for the active sonar case is also desirable. The aircraft avionics should have minimum hardware and software impact; however, it is obvious that some command and display functions may have to be modified. Consideration should be done as to interaction of the air platform, the source and the receiver and the distribution of effort among the three elements: source, receiver and aircraft.

PHASE I: Perform a modeling and/or simulation effort to prove feasibility. Plan the development of innovative signal and information processing algorithms.

PHASE II: Develop and refine the signal and information processing algorithms based on the results of Phase I. Design and demonstrate a floating breadboard prototype system Coordinate field tests to gather and analyze data to improve and verify signal processing.

PHASE III: Transition the innovation into a new sonobuoy set as well as into an existing aircraft antisubmarine warfare (ASW) system. Convert the algorithms into source code for an aircraft sonar acoustic system and its system of sources and receivers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An application of this technology may also be of interest to those who study the ocean environment and often employ objectional sound levels; such as, seismic analysis (using high-powered sound) of the ocean floor in search of oil as well as in covert intrusion detection.

REFERENCES:
1. Viterbi, A. CDMA: Principles of Spread Spectrum Communication, Addison-Wesley, 1995.

2. Kopp, Carlo, "An Introduction to Spread Spectrum Techniques," 2nd Ed, 2005, online: http://www.ausairpower.net/OSR-0597.html.

3. Burdic, William S. “Underwater Acoustic Systems Analysis” Prentice-Hall, Englewood Cliffs, NJ, 1984.

4. Pickholtz, R. L., Schilling, D. L., and Milstein, L. B. Revisions to “Theory of Spread-Spectrum Communications – A Tutorial” IEEE Trans. Commun., vol. COM32, no. 2, Feb 1984, online: http://www.bee.net/mhendry/vrml/library/cdma/cdma.htm

KEYWORDS: Pseudo-noise; Spread Spectrum; Sonar; Antisubmarine Warfare; Ocean Mammal Mitigation; Anti-Jam Sonar

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-006 TITLE: Prognostic & Health Management (PHM) Technologies for Unmanned Aerial Vehicles (UAV)

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA-290, Maritime Patrol and Reconnaissance Aircraft

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OBJECTIVE: Develop a diagnostic and prognostic architecture to enable a condition based maintenance system for Unmanned Aerial Vehicles (UAV).

DESCRIPTION: With the advent of significantly more complex Unmanned Air Vehicles (UAV) in the DoD inventory and the unique challenges and opportunities they present, integration of the typical Prognostics & Health Management (PHM) System from a manned platform is not always optimal. UAVs present unique challenges in the diagnostics, prognostics and health monitoring of engines and drive systems, sensors (electro-optical/infrared (EO/IR), Radar, etc), electro-mechanical actuator (EHA), and communications, during endurance missions. Wherein the pilot debrief is often used to identify changes in engine performance or aircraft handling characteristics for maintenance purposes, without a pilot in the loop, the PHM system on UAVs must be relied upon to a greater extent to report propulsion faults and drive maintenance actions. Propulsion faults such as compressor surge/stall, vibrations, and screech can often be identified by auditory or vibration changes in a manned platform. This detection is obviously not available on unmanned platforms, making it more difficult to detect, diagnose, and repair propulsion system problems.

While there are many challenges associated with UAVs, there are also many unique opportunities presented with integrating a PHM system. With the UAV under continual downlink connectivity, there exists the possibility to perform highly complex diagnostic routines and prognostic algorithms near real time (NRT) offboard in the ground control station (GCS). This can free up limited computational resources and memory capacity for more safety critical routines. UAVs are also highly electronic-digital systems that already utilize a vast array of system sensors embedded with various flight critical and mission essential components for system control. As such, these sensors could be easily integrated and networked with the PHM system and potentially provide redundant fault tolerant adaptive control.

Based on these unique characteristics, explore innovative PHM concepts that optimize diagnostic, prognostic and health monitoring functionality for UAVs. Design approaches should assure full coverage of all safety critical, flight critical and mission essential hardware while minimizing onboard space and weight. The system should identify an optimal design approach and architecture to effectively and efficiently utilize both onboard and offboard processing capability. Approaches should fully support the implementation of condition based maintenance (CBM) practices and enable simplified Organic to Depot (O-D) level maintenance in an autonomic logistics environment. The PHM system must also be capable of automatically adjusting for lack/loss of datalink bandwidth such that no data is lost and no safety or flight critical faults are missed. With an emphasis placed on endurance and maximizing fuel capacity, the UAV PHM system will need to adhere to stringent weight and space constraints.

Coordination with a UAV manufacturer is recommended.

PHASE I: Define and determine the feasibility of providing a dependable and robust PHM system for enabling condition based maintenance on UAVs.

PHASE II: Provide a model of the recommended architecture, hardware, algorithms and demonstrate the ability to detect faults and drive CBM actions. Develop, demonstrate and validate the final application for the model maximizing PHM functionality while meeting stated requirements. Demonstrate the capability of the prototype equipment.

PHASE III: Integrate the system on-board an aircraft with flight qualified hardware and software. Incorporate the technology with a defense program of record and determine the system’s compatibility with legacy and future applications. Transition the completed UAV PHM system to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Unmanned Aerial Vehicles are increasingly being used for border patrol, land and atmospheric surveys, and law enforcement. These UAVs would benefit from a PHM/CBM system by minimizing repair cost and increasing time-on-station. A robust PHM system would also provide increase safety in a community environment that may assist with Federal Aviation Administration (FAA) commercial airspace integration.

REFERENCES:

1. Henley, Simon; Currer, Ross; Sheuren, Bill; Hess, Andy; and Goodman, Geoffrey. "Autonomic Logistics—The Support Concept for the 21st Century." IEEE Proceedings, Track 11, paper zf11_0701. http://ieeexplore.ieee.org/search/srchabstract.jsp?arnumber=877915&isnumber=18960&punumber=7042&k2dockey=877915@ieeecnfs&query=%28%28autonomic+logistics%29%3Cin%3Emetadata%29&pos=1&access=no

2. Byer, Bob; Hess, Andy; and Fila, Leo. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics." Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095-3103; http://ieeexplore.ieee.org/search/srchabstract.jsp?arnumber=877915&isnumber=18960&punumber=7042&k2dockey=877915@ieeecnfs&query=%28%28autonomic+logistics%29%3Cin%3Emetadata%29&pos=1&access=no

3. SAE E-32 Committee Documents. http://www.sae.org/servlets/works/documentHome.do?comtID=TEAE32

4. IEEE Aerospace Conference Proceedings for 2001 and 2002, Track 11 PHM.

KEYWORDS: unmanned aerial vehicle; diagnostic; prognostic; sensor; prognositcs health management; condition based maintenance

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-007 TITLE: Efficient Multi Fuel Tank Inerting System

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA 275, V-22 Program

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and demonstrate an efficient multi fuel tank inerting system that requires no bleed air, minimal electrical power and no pre-stored inerting agent.

DESCRIPTION: Aircraft fuel tanks have traditionally been protected from both ballistic and safety fires by either filling the tanks with explosion suppressant foam (ESF) or filling the ullage, the area above the fuel level, with an inert gas. Inert gas is the preferred method since ESF is heavy, reduces fuel tank capacity and is more expensive to maintain. However, traditional On Board Inert Gas Generating Systems (OBIGGS) use a physical separation media that requires more electric power and bleed air to operate than many aircraft have available. OBIGGS can also be difficult to integrate into multi tank applications. An innovative and efficient inerting system that does not rely on a pre-stored inerting agent (such as compressed nitrogen to prevent logistical issues) that is capable of supporting multiple independent tanks would improve the safety and survivability of military aircraft.

PHASE I: Design and develop an innovative approach for a multi-tank inerting system that requires no bleed air, minimal electricity and is capable of inerting multiple independent tanks to less than 9% oxygen concentration by volume without contaminating the fuel. Demonstrate the feasibility of applying the developed approach in a laboratory environment.

PHASE II: Finalize design and demonstrate practical implementation of a production-scalable prototype inerting system. Evaluate the prototype system through demonstration testing on the replica of a military aircraft multi-tank fuel system.

PHASE III: Transition the approach to the fleet and other candidate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A rule mandating commercial aircraft center wing tank inerting using OBIGGS or similar systems is pending. Boeing is already installing OBIGGS systems on newer commercial airliners. An innovative inerting system that is more efficient than traditional OBIGGS can be transitioned to the commercial fleet to enhance both safety and reliability.

REFERENCES:

1. McDonald, George H., et al "Catalytic Reactor for Inerting of Aircraft Fuel Tanks." AiResearch Manufacturing Company. 1974

2. Reynolds, Thomas L., "Gas Separation Technology: The State of the Art"; Halon Options Technical Working Conference, 24-26 April 2001.

KEYWORDS: Fuel; Tank; Inerting; OBIGGS; Safety; Survivability

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-008 TITLE: Insensitive Munitions Compliant Initiation System

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-259 - AIM 9X Block 3 Upgrade

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OBJECTIVE: Develop an advanced initiation system that is Insensitive Munitions (IM) compliant and capable of initiating high-performance insensitive energetics, which pose a problem for current initiation systems.

DESCRIPTION: Current weapon systems must meet IM requirements under which weapons are to be immune to external threats in their environments and respond in a benign manner when exposed to these threats. The IM requirements include passing fragment impact, bullet impact, slow cookoff, fast cookoff, shaped charge jet and sympathetic detonation tests. This need has been partially met by decreasing the sensitivity of the main charge fill and modifying the warhead case design. As a result, many weapons are now capable of meeting several of these requirements but few meet all of the required responses.

A new approach to initiation is needed that is not susceptible to the above mentioned threats and still meets the affordability and operational energy requirements of conventional weapon systems. Recent studies and technological developments suggest there is an achievable path to achieving full IM compliance without decreasing weapon system performance. The primary challenge for this development will be to use low cost/firing energy components to initiate insensitive explosive fills and maintain immunity to the threats listed above. A secondary challenge of this effort will be to selectively control the initiation system output to modify the performance of the warhead. The developed initiation system should demonstrate a hazard level 1.6 compliance, maintain current weapon system initiation system costs, and reduce the cost of meeting IM goals. Additionally, there is a desire for selectivity in the initiation system to enable control of the output characteristics of the warhead. A secondary goal is to develop a multipoint system that requires no more energy than a two- point exploding foil initiator (EFI) system.

PHASE I: Develop an initiation system concept and demonstrate its feasibility of operation against a standardized IM explosive fill, with timing characteristics sufficient to meet missile ordnance section requirements. The design must use secondary explosives qualified for in-line use and have analysis or test data demonstrating the ability to meet the requirements of MIL-DTL-23659.

PHASE II: Develop a prototype and perform component and system level testing to demonstrate that performance goals are met and performance variations have been established.

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 IAW DoD 5220.22-M during the advance phases of this contract.

PHASE III: Transition developed technologies into a Navy weapon system to meet the specific program needs. Integrate the technology into the existing safety system and associated warhead to minimize the development cost and program risk.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Use of this technology in the private sector will be limited to homeland defense where safety critical applications will benefit from implementation. Potential applications in demolition and mining industry will be investigated for application of a reduced performance design.

REFERENCES:
1. NAVSEA INSTRUCTION 8020.5C

2. MIL-STD-1316, Safety Criteria for Fuze Design.

3. MIL-STD-2105C, Hazard Assessment Tests for Non-Nuclear Munitions.

4. MIL-DTL-23659, General Design Specification for Initiators, Electric.

5. MIL-STD-1751A, Safety and Performance Tests for the Qualification of Explosives (High Explosive, Propellants and Pyrotechnics)

6. NAVSEAINST 8020.8C

KEYWORDS: Insensitive; Munitions; Initiation; System; Detonation; Warhead; Ordnance

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-009 TITLE: <u>Novel Laser Gain Media</u>

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMA 264, Air ASW Systems; AIR-290

OBJECTIVE: Develop high efficiency laser gain media with fundamental transitions or frequency multiplied transitions in the 20,300 cm-1 to 21,800 cm-1 region

DESCRIPTION: Currently, fundamental research into laser gain media with transitions suitable for stimulated emission in the 20,300 cm-1 to 21,800 cm-1 region is insufficient. State of the art gain media with transitions in this region include Ti:Sapphire (doubled), Nd:YAG (946nm doubled) [1-3], and Cr:LiSAF (doubled) [4]. However, generation of light in the desired waveband is typically achieved with multiple stage lasing/amplifying/nonlinear wavelength shifting. Such a multistage process is inherently inefficient. Hot metal vapor, and chemical lasers typically have operational issues due to the desire to avoid HAZMAT, hot gases and liquids within the aircraft. Liquid lasers based on flowing liquid have additional complications due to strict plumbing requirements on aircraft. Additionally, areas of operation may include highly humid environments making the use of hygroscopic and cryogenic crystals challenging.

Gain media with fundamental transitions or transitions that can be frequency multiplied into this region are sought. Gain media for solid state and fiber lasers are preferred, however alternate laser media will be considered. Gain media must be amenable to pulsed laser design; proposals for gain media should address the potential for the material to be used in a laser system capable of meeting all parameters simultaneously. Gain media should have the potential to be developed into ruggedized airborne military laser operating in a harsh environment. Gain media should support maximum of nanosecond pulses (~20 ns), and pulsed operation in 500 Hz to 1 kHz range. All proposals should discuss practical considerations driving minimum and maximum pulse rate and effect of repetition rate on energy per pulse of theoretical laser based on gain media. It should have fundamental transition and high energy per pulse potential as measured in the 20,300 cm-1 to 21,800 cm-1 region. (Threshold: 10 mJ/pulse, Objective: 20 mJ/pulse). The high damage threshold should be consistent with laser output of 10 W average power and 10 mJ at 1 kHz repetition rate. Narrow laser linewidth (Threshold: 0.1 nm, Objective: 0.01nm); lasing transition without cavity can be broad. Gain media should have pump bands that can be COTS diode or COTS laser pumped.

PHASE I: Determine feasibility of proposed gain media achieving all parameters. Define plan for the development of the proposed media into laser grade material.

PHASE II: Develop, demonstrate and validate prototype laser grade gain media.

PHASE III: Build, characterize, and deliver laser using Phase II gain media. It is anticipated that the small company may need to partner with laser manufacturer.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Oceanographic bathymetry systems for survey and exploration work would benefit greatly from gain media with a more efficient transition in the in the 20,300 cm-1 to 21,800 cm-1 range. The gain media proposed in this SBIR will remove a critical impediment to more efficient laser transmitters in this wavelength.

REFERENCES:
1. M. E. Thomas, A. K. Carr, D. Limsui, and J. C. Huie, “Optical Properties of Nd Doped and Undoped Polycrystalline YAG”, Proc. of SPIE Vol. 6545 65450F, 2007.

2. Theresa J. Axenson, Norman P. Barnes, and Donald J Reichle, “946 nm diode pumped laser produces 100 mJ”, Proceedings of SPIE, Vol 4153, 2001.

3. Theresa J Axenson, “High Energy Q-switched 0.946 um solid state diode pumped laser”, J. Optical Society of America B, Vol 19, No 7, 2002.

4. Stephen A Payne, et al, “Properties of Cr:LiSrAlF6 crystals for laser operation”, Applied Optics, Vol 33, No 24, 20 August 1994; http://adsabs.harvard.edu/abs/1994ApOpt..33.5526P

5. Optical Propagation in Linear Media, Michael E. Thomas, Oxford University Press, 2006.

6. Absorption and Scattering of Light by Small Particles, Craig F. Bohren, Donald R. Huffman, Wiley-VCH, 2004.

7. Solid State Laser Engineering, W. Koechner, Springer Science, 2006.

KEYWORDS: Gain Media; Solid State Gain Media; Oceanographic Lidar; Optical Communication; Underwater Optical Communication; Fiber Laser

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-010 TITLE: Real Time RF Range Delay Emulation

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: PMA-265, Super Hornet, Hornet; Air 5.4.4.2; Next Generation Jammer

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OBJECTIVE: Develop a technology to test a digital radio frequency memory (DRFM) device in an installed system test facility (ISTF) with a realistic model of one-way range delay between the DRFM and other facility assets with limited degradation of the injected signal.

DESCRIPTION: A concept is required that will result in the development of a system to operate from 100 MHz to 18 GHz providing dynamic controlled time correction characteristic of free space propagation with respect to a simulated moving target in a coaxial environment. The development of the range delay emulator should be programmable, with the capability to correctly adjust for one-way propagation time induced by the slant range from the system under test (SUT) to a simulator. The time correction must account for both the fixed inherent ISTF infrastructure delay, along with the dynamic predicted simulated target position. The injected signal is required to have the dynamic time correction applied with limited degradation of the injected signals, to include noise additions. The emulator should also provide an interface for external target data inputs, correcting time delay values representative of the simulated one-way range in a dynamic scenario. This capability will provide a cost savings to the government by providing a means of testing DRFM systems in an ISTF, thereby reducing the time required for the more expensive flight test environments. This external interface is required for integration with the Joint Integrated Mission Model (JIMM) to be compatible with existing stimulators at the facility.

PHASE I: Determine feasibility of and develop a conceptual design for an appropriate real time range delay emulator.

PHASE II: Develop detailed designs for the Phase I range delay emulator and fabricate a prototype suitable for proof of concept testing in a laboratory environment. Conduct preliminary testing demonstrating the one-way range delay capabilities and performance.

PHASE III: Integrate Phase II prototype via external interface with a real-time executive using the Joint Integrated Mission Model (JIMM) thus allowing use with existing RF stimulators resident at the test facility. Develop and fabricate a full-scale multi channel emulator. This emulator will provide full-scale demonstration of all capabilities and will lead to a full-scale prototype demonstration unit.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The range delay emulator can be used to test commercial cellular, RF data links, and other communication systems.

REFERENCES:

1. Skolnik, Merill, Radar Handbook, Third Edition, McGraw, 2008

2. Stimson, George W., Introduction to Airborne Radar, Second Edition, 1998

3. Neri, Filippo, Introduction to Electronic Defense Systems, Second Edition, SciTech Publishing, 2006

KEYWORDS: Delay; Radio Frequency (RF); Digital Radio Frequency Memory (DRFM); Radar; Real-time; Programmable

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-011 TITLE: Hand-Held Nondestructive Inspection (NDI) Scanner for Composite Missile Systems

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-259, Air-to-air Missile Systems; ACAT I

OBJECTIVE: Develop a hand-held non-destructive inspection (NDI) device that can scan complex contoured composite missile structures, e.g. fiber-reinforced plastic (FRP) tubes and FRP sandwich structures.

DESCRIPTION: Composite materials are the future structural material for missile systems as well as complex contoured aero structures. These materials provide higher strength and less weight than traditional metal cases. Composite materials are sensitive to impact damage, frequently as a result of handling accidents. If composites are to be truly viable in the Navy, there must be a method for quickly and nondestructively analyzing an asset after such an accident. Currently methods for nondestructive inspection of composite materials are limited to flat-plate or nearly flat-plate geometries. Missiles do not fit into this limitation due to their small diameter, typically between 2 and 25 inches.

The hand-held device will have to detect defects as small as 0.100 inches diameter or 0.050 inch-wide cracks in both curved and flat surfaces. The device will need to detect delaminations, kissing unbonds, broken fibers, and other defects. It must be portable to allow a sailor to scan a part while stored on a ship at sea. It must have a real-time display with a scale representation of the defect. Energy from the scan cannot interfere with or excite solid rocket propellant or affect sensitive electronics. Only the exterior of missiles will be accessible to the scanner; therefore, it must be able to see through fiberglass, graphite, and aramid reinforcements. Matrix materials may include epoxies, cyanate esters, polyimides, and bismaleimides. Some portions of missiles may be constructed of sandwich panels with aluminum or aramid honeycomb cores. There will also be a paint coating on the exterior of the composite parts. The device must be capable of scanning through the entire thickness of the case, which can vary from 0.060 inches to 0.750 inches. An additional capability would be to detect delaminations in the rocket motor sections between the case to insulation, insulation to liner, and liner to propellant.

PHASE I: Conceptualize and design an innovative nondestructive method for inspecting small-diameter composite structures for the defects listed. Demonstrate technical feasibility.

PHASE II: Develop, demonstrate, and validate a prototype hand-held device capable of detecting the aforementioned defects. Establish performance parameters via experiments and prototype fabrication. Complete component design, fabrication, and laboratory characterization.

PHASE III: Transition the NDI unit to a naval weapon system such as the Advanced Medium Range Air-to-Air Missile.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Hand-held NDI units will make for quicker and easier inspection of many composite products that are currently commercially produced.

Wind energy, automobiles, and commercial aviation are all increasingly using composites and stand to gain from this technology. The device could be used for quality control purposes during manufacturing.

REFERENCES:
1. MIL-HDBK-17-3F, Department of Defense Handbook, Composite Materials Handbook, Volume 3. 17 June, 2002

2. Kobayashi, M., Jen, C., L´evesque, D., Flexible Ultrasonic Transducers. IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 53 (8), 1478-1486, 2006

KEYWORDS: Nondestructive Inspections; Composite; Delaminations; Rocket Motors; Portable; Scanner

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-012 TITLE: <u>Strained Layer Superlattice Dual Band Mid-Wavelength Infrared/Long Wavelength Infrared (MWIR/LWIR) Focal Plane Arrays</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: PMA-263, Navy Unmanned Aerial Vehicles Program

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OBJECTIVE: Demonstrate a Strained Layer Superlattice (SLS) dual band, large format, Focal Plane Array (FPA) operating in the Mid-Wavelength Infra-Red (MWIR) and Long Wavelength IR (LWIR) regions.

DESCRIPTION: Focal Plane Arrays are the critical element in modern Electro-Optical/Infra-Red (EO/IR) sensors that convert radiation from the scene/target into electrons. Using the latest technologies it is now possible to fabricate a new class of FPAs which not only hold the promise of being less expensive, but also exceed the capabilities of current FPAs. The Strained Layer Superlattice (SLS) has already been demonstrated in smaller (240x320) FPAs with higher quantum efficiencies and operability than other dual band FPAs (e.g. Mercury Cadmium Telluride (MCT)). This technology would build on MDA development efforts to demonstrate large format dual band (LWIR/LWIR) FPAs for a wide variety of applications.

Proposed concepts should be able to utilize the dual band Readout Integrated Circuits (ROIC) developed for the LWIR/LWIR (two Long Wavelength Infrared (LWIR) sub bands in the 8-14 micron region) application, and focus on MWIR/LWIR (a Mid Wavelength Infrared (MWIR) band in the 3-5 micron region and a Long Wavelength Infrared (LWIR) band in the 8-14 micron region) material development and FPA fabrication.

The current emphasis on developing these SLS FPAs is sponsored by the Missile Defense Agency (MDA) who is interested in Dual Band (LWIR/LWIR) devices for their unique applications. MDA has a $20M development effort underway addressing materials, ROICs, and fabrication processes. This SBIR is intended to build on the MDA work, but emphasize demonstration of Dual Band operation across the Mid-Wavelength IR and Long Wavelength IR regions.

PHASE I: Design and develop an approach for MWIR/LWIR material fabrication, interfacing with large format (1k x 1k) ROICs under development by MDA, and demonstrate the technical feasibility of a fabrication process.

PHASE II: Develop, demonstrate, and validate dual band material (MWIR/LWIR) integrated with the large format ROICs (provided by MDA), and fabricated into SLS Dual Band FPAs. Install developed prototype in a suitable dual band camera for evaluation and demonstration. For this evaluation, a non-optimized cooler/dewar assembly would be used.

PHASE III: Fully develop and integrate the Dual Band FPA into a detector, dewar, cryo-cooler assembly suitable for flight testing. Perform validation and certification testing in an airborne IR system and transition the capability into the next generation of IR sensors for airborne platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Affordable Dual Band IR technology could find several commercial applications in collision avoidance applications, in agricultural surveying, and imaging applications in hostile environment (weather, fire and smoke).

REFERENCES:
1. Zheng, L., Tidrow, M., et al, "Type II strained layer superlattice: a potential infrared sensor material for space", SPIE Proceedings, Vol. 6900, paper 69000F-1, 2008.

2. Delaunay P., Razeghi, M., "High performance focal plane array based on type-II InAs/GaSb superlattice heterostructures", Proc. of SPIE Vol. 6900, paper 69000M, 2008.

3. Hill, C., et al, "MBE grown type-II superlattice photodiodes for MWIR and LWIR imaging applications", Proc. of SPIE Vol. 6660, 66600H, 2007.

4. Aifer, E., et al, "Recent progress in W- structured type-II superlattice photodiodes", Proc. of SPIE Vol. 6479, 64790Y, 2007.

5. Aifer, E., et al, "Very-long wave ternary antimonide superlattice photodiode with 21 mm cutoff", Applied Physics Letters Volume 82, Number 25 23 June 2003.

6. Nguyen, B., et al, "Dark current suppression in type II InAs/GaSb superlattice long wavelength infrared photodiodes with M-structure barrier", Applied Physics Letters 91, 163511, 2007.

KEYWORDS: strained layer superlattice; quantum efficiency; operability; focal plane array; dual band MWIR/LWIR; affordability

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-013 TITLE: <u>Low Cost, Dual Purpose Engine Control and Diagnostic Sensors</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: JSF-Prop; PMA-261, H-53; Prognostic Diagnostic Based Maintenance (PDBM)

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OBJECTIVE: Develop and demonstrate low cost sensor capable of performing engine control and engine diagnostic functions using state-of-the-art mechanical and electronic technology.

DESCRIPTION: Develop and demonstrate sensors with characteristics acceptable for the dual purpose of control and diagnostics of engine sub-systems. Engine sub-systems include but are not limited to the compressor section, turbine section, fuel, lube, oil, and ignition systems as well as gearboxes and bearings. The sensors should have a combined weight equal to or less than current engine control and diagnostic sensor suites and have at least a 25 percent cost reduction compared to current engine control and diagnostic sensors. The sensors have to be reliable and survive the temperature and vibration levels typical of the location at which the measurement is being performed. Utilize the IEEE 1451.4 Standard for Smart Sensors and Transducer Electronic Data Sheets (TEDS). The sensors should also make use of micro electro mechanical system (MEMS) technology to the fullest extent possible.

State-of-the-art controls act on sensed engine parameters which provide measurements at fixed time intervals. All signals travel through a dedicated path requiring signal loss to be substituted with an identical signal. Current control systems lack any meaningful integration with engine prognostics systems. The need for greater reliability and reduced operating costs requires greater integration and in-situ evaluation of the engine data through innovative concepts for multi-layered, self-calibrating and self-diagnosing sensors suite.

PHASE I: Determine the feasibility of providing dependable, robust, and affordable dual purpose sensors.

PHASE II: Develop and demonstrate a prototype of the concept designed in Phase I. Provide the architecture, sensor suite, wiring harnesses, and algorithms required to perform engine control and diagnostic sensing. Demonstrate the prototype's ability to detect faults and provide high fidelity information necessary for engine control. Demonstrate the systems capability to maximize Prognostics and Health Management (PHM) functionality while meeting stated requirements.

PHASE III: Demonstrate the system on-board an aircraft with flight qualified hardware and software. Incorporate the technology with appropriate production aircraft and determine the system’s compatibility with legacy and future applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A light weight and affordable means of providing both engine control and propulsion diagnostic sensing could have far reaching potential within commercial aviation.

REFERENCES:
1. Schwabacher, Mark A., “A Survey of Data-Driven Prognostics”, http://ti.arc.nasa.gov/m/profile/schwabac/AIAA-39300-874.pdf

2. Behbahani, Alireza R., “Need For Robust Sensors For Inherently Fail-Safe Gas Turbine Engine Controls, Monitoring and Prognostics”, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA467099&Location=U2&doc=GetTRDoc.pdf

3. IEEE 1451.4 Standard for Smart Transducers; http://standards.ieee.org/regauth/1451/Tutorials.html

KEYWORDS: Diagnostics; Prognostics; Sensors; PHM; Vibration; Reliability

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-014 TITLE: <u>High Gain Array of Velocity Sensors</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: Advanced Extended Echo Ranging (AEER) ACAT IV; PMA-264, Air ASW Systems

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OBJECTIVE: Develop a concept for a free floating high gain array of velocity sensors that is deployable in an inexpensive A-size sonobuoy and can operate passively in deep and shallow water.

DESCRIPTION: A sonobuoy that could provide large array gain (>24db required) would be an appealing complement to the US Navy’s airborne Anti-Submarine Warfare (ASW) acoustic capability. To provide this much gain in an A-size form factor* it is necessary to make maximum use of velocity sensors. The use of velocity sensors has the potential to reduce the array aperture by a factor of three or four. Both two and three axis velocity sensors have been initially analyzed for a line array of velocity sensors under isotropic noise conditions [1]. To realize maximum gain it is expected that realistic vertical ambient noise profiles will have to be used to determine the array gain from various sites, sensors and depths. The array should be designed for frequencies on the order of 1000 Hz and the sonobuoy bandwidth shall be determined by the aggregate bandwidth which is a function of the acoustic bandwidth of the individual sensors, number of sensors, and the number of bits per sample. The sensor array must be compatible with the A-size sonobuoy form factor and employ the new sonobuoy digital data link. In-buoy signal processing is allowed to alleviate data link issues.

The new data link shall employ Continuous Gaussian Frequency-Shift Keying (CGFSK) with a signal data rate of 320 kbits, a modulation index of 0.75, and a bandwidth time product of 0.3. A total of 288 kbits shall be used for nominal acoustic data transmittal, with 32 kbits reserved for overhead. This Radio Frequency (RF) constraint is noted due to the expected large number of channels generated by two or three axis velocity sensors. Appropriate processing and beamforming shall be implemented to take full advantage of velocity sensor potential.

In addition to the array geometry, and because of the large number of velocity sensors expected to be needed, a major challenge of the effort will be sonobuoy development.

* A-size – refers to the standard U.S. Navy Sonobuoy form factor: right-circular cylinder of diameter d=4.875” and of length L=36”; maximum weight is 39 lbs.

PHASE I: Develop an initial conceptual design for the high gain (>24db) velocity sensor array. Perform modeling and simulate candidate arrays in realistic noise fields at various sites, sensors and depths. Develop innovative packaging concepts for an A-size design. Develop or identify innovative design for small inexpensive velocity sensors.

PHASE II: Develop, construct, and demonstrate the operation of a prototype array through over the side testing utilizing electronically generated broadband and narrowband signals. Validate the over the side prototype meets design goal for array gain. Provide signal processing needed to demonstrate array performance. Complete component design and fabrication of an A-size prototype to illustrate packaging concepts.

PHASE III: Develop a production design of Phase II solution. Demonstrate full operational functionality in Navy-supported test scenarios. Transition the developed technology for fleet use and provide a detailed supportability plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Passive detection of acoustic signals from the array has potential applications in marine mammal detection, drug interdiction and terrorist security systems. The Coast Guard will find it useful in coastline and harbor defense.

REFERENCES:
1. Cray, Benjamin A., Nuttal, Albert H., “Directivity Factors for Linear Arrays of Velocity Sensors”, J. Acoustic Soc. Am. 110 (1) pg 324-33, July 2001.

2. Silvia, Manual T., “Theoretical and Experimental Investigation of Acoustic Dyadic Sensors”, SITTEL Corporation Technical Report TP 4, Jul 25 2001, (DTIC Report No. ADA3433).

3. Urick, R. J., “Principles of Underwater Sound”, 3rd Edition, McGraw Hill, 1983.

4. McConnell, J. A., Jensen, S. C., Rudzinsky, J. P., “Forming First-and Second-Order Cardioids Using Multimode Hydrophones“, MTS/IEEE Oceans 2006 Conf. Proc., Boston, MA, September 18-21, 2006.

KEYWORDS: passive acoustics; velocity sensors; arrays; array gain; two-axis; three-axis

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-015 TITLE: Virtual Vibration Testing Of External Stores

TECHNOLOGY AREAS: Air Platform, Battlespace, Weapons

ACQUISITION PROGRAM: Joint Strike Fight; PMA-259, Air-to-Air Missile Systems

OBJECTIVE: Develop a structural dynamics modeling tool which will provide an accurate physics-based solution for predicting non-linear vibration response, and employ the modeling tool for conducting “virtual” vibration testing.

DESCRIPTION: Because of the complexity and extreme cost associated with "high fidelity simulation" of vibration loads in a laboratory environment, the current practice and goal of the laboratory vibration test is to recreate the effects of the service use vibration environment using electrodynamic shaker systems. Electrodynamic shakers provide input excitation for matching store vibration response measured during captive carriage flight testing.

Vibration excitation resulting from platform captive carriage is transmitted to the weapon through multiple paths and sources; whereas, in a laboratory vibration test, loads are typically induced through a single shaker input. Likewise, the laboratory test boundary conditions and resulting load interface impedances can be significantly different than the “real world” or service use environment. As a result of the differences in load path, boundary conditions, and impedances between flight and the laboratory, input forces generated during test can be much different than those experienced during flight causing unrepresentative failures. Examples where laboratory vibration test loads created unrepresentative failures during all-up-round (AUR) testing include complete failure of forward and aft components and bomb racks for various AUR bomb vibration tests, and lug, hanger, component joint, and launcher failure during HARM, Sparrow, Sidewinder, and JSOW testing. Failures due to insufficient testing have significant impact on design cost and schedule which result in critical delivery impact to the warfighter.

An alternate approach would use a highly accurate dynamic modeling tool to analyze the laboratory test configuration for comparison with the “real world” store / aircraft interface, and allow for “tuning” of the laboratory test configuration to achieve test loads that more accurately represent the service use environment. Tuning of the laboratory test would include test fixture design that more accurately represents the service use store/aircraft interface along with accurate estimates for optimum location of the shaker input forces. Upon completion of the modeling, a "virtual" laboratory vibration test could be conducted which would assess the test configuration and resulting failure modes prior to conducting the actual test. Eventual validation of the virtual test model could then be used to forgo future laboratory vibration testing to qualify airframe or other system modifications which may occur as the weapon system matures.

The current practice of using finite element analysis (FEA) for modeling and predicting vibration response of complex, non-linear structural systems does not provide the necessary accuracy at frequencies much beyond the first few structural modes of the weapon system. Because commercially available FEA tools utilize linear elastic theory only, FEA can not accurately predict vibration response due to inherent nonlinearities associated with either the aircraft/store interface or the laboratory shaker system interface.

In order to exercise the linear-elastic FEA models to output results for use with non-linear vibration problems, the FEA model is typically adjusted by a process which introduces non-realistic structural properties to achieve dynamic response equivalent to output derived experimentally for a unique set of boundary conditions only. Thus, the development of a dynamic modeling tool which combines the ability of linear elastic theory and non-linear problem solving algorithms would provide a robust physics-based solution to process virtual vibration test models, rather than the "trial-and-error" methodology currently in practice which relies entirely on experimental data for each unique structural non-linearity and associated dynamic environment.

PHASE I: Develop a concept for an accurate non-linear structural dynamics model for a simple non-linear store / aircraft configurations e.g., store hanger and rail.

PHASE II: Develop and demonstrate an accurate non-linear structural dynamics model for a typical store/platform configuration and apply the information to design an accurate non-linear structural dynamics model for a typical store/shaker interface configuration. Verify results output by the non-linear store/shaker interface structural dynamics model by conducting vibration testing on representative store/platform configuration hardware using various random vibration input levels and spectra.

PHASE III: Produce a validated virtual vibration test system based on the non-linear structural dynamics modeling tool developed in Phases I and II.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The structural dynamics design industry e.g., those involved in manufacture of automobiles, heavy equipment, buildings, bridges, space vehicles, weapons, recreational vehicles and accessories, etc. will benefit through extension of their technology base.

REFERENCES:
1. "Harris" Shock and Vibration Handbook", 5th Edition, Cyril M. Harris and Allan G. Piersol editors, McGraw-Hill, New York, 2002

2. MIL-STD-810G, "Environmental Engineering Considerations and Laboratory Tests", 31 October 2008

KEYWORDS: vibration; structural dynamics; modeling; non-linear; virtual testing; electrodynamic shaker

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-016 TITLE: Lightweight, Accurate Bleed Flow Measurement for Gas Turbine Engines

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA-261, H-53 Heavy Lift Helicopters; Prognostic Diagnostic Based Maintenan

OBJECTIVE: Develop innovative small, lightweight, low cost turbine engine compressor discharge bleed flow measurement system capable of efficient measurement for high volume bleed flow applications.

DESCRIPTION: Accurate measurement of engine bleed flows are required to accurately calculate the current performance capability of turbine engines. Currently fielded turbine engines have either no measurement capability or employ a venturi system which is heavy, expensive, and suboptimal for high volume flows. Modern weapon systems are being developed with real-time power available calculation capability with feedback to the aircrew for improved situational awareness. Bleed flow has a significant impact on the accuracy of these calculations, and the current outputs are unnecessarily conservative. Accurate measurements of these bleed flows will enable accurate calculation of current power available, improving safety as well as optimizing mission planning and maintenance.

Cooperation with an original equipment manufacturer of turbine engines is recommended.

PHASE I: Design and develop a proof of concept approach to measure a wide range of compressor discharge pressure bleed flows in gas turbine engines.

PHASE II: Develop, fabricate and test a prototype in a relevant environment to demonstrate the capability of the sensor to accurately measure bleed flows.

PHASE III: Finalize the sensor system application and conduct necessary qualification testing for transition to both military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The lightweight, accurate bleed flow measurement sensor developed under this topic would significantly enhance the state of the art for commercial aviation. The technology is directly transferable to military and commercial turbine engine applications.

REFERENCES:

1. Kevin Sullivan's Autoshop101 Website; "Air Flow Sensor", http://www.autoshop101.com/forms/h34.pdf

2. Fralick , Gustave C., Wrbanek , John D., and Hwang , Dr. Danny P.; "Thin-Film Air-Mass-Flow Sensor of Improved Design Developed", http://www.grc.nasa.gov/WWW/RT/RT2002/5000/5510fralick.html

3. Robertson, John A., Crowe, Clayton T.; "Engineering Fluid Mechanics", Sixth Edition, Chapter 13 – Flow Measurements.

KEYWORDS: bleed flow; turbine engine; sensor; power available; compressor discharge; venturi

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-017 TITLE: <u>Miniature Laser Designator for Small Unmanned Aircraft Systems</u>

TECHNOLOGY AREAS: Air Platform, Electronics, Weapons

ACQUISITION PROGRAM: PMA-263, Navy Unmanned Aerial Vehicles Program; PMA-266

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OBJECTIVE: Design and develop a high performance compact infrared laser designator system to be integrated with small unmanned aerial vehicles (UAV).

DESCRIPTION: Innovative compact and low weight illuminator concepts are required to provide small UAS targeting capabilities. To accommodate the limited volume in either the nose or expansion bays of prospective UAV platforms, compact electronics, a miniature solid state IR laser operating at 1064 nm, and compact light weight precision optics are needed to be designed, developed and packaged with a micro-gimbal to provide an environmentally robust illuminator which will meet size, weight, performance and cost requirements. Proposed concepts should include a micro-gimbal and be inertially stabilized to track and paint moving targets without having to reorient the aircraft. The high brightness illuminator should be capable of meeting or exceeding all environmental requirements. The laser designator system should be optimized for low weight, (less than one kg including the gimbal), and low volume. The weight should be apportioned such that the gimbal is approximately 0.4 kg and the remainder is for the laser, electronics and optics. The complete package should be designed to fit in a payload bay with a 7" diameter and a length not exceeding 9". The use of novel methods such as light weight environmentally robust polymer optics, micro-electro mechanical systems (MEMS) technology and other technological innovations will likely be required to meet size and weight requirements. The system should operate at 1064 nm and provide output pulse energy of 30mJoule using pulse width modulation (PWM) methods to generate operationally relevant laser codes. The beam should have a range of 1-3km in clear weather conditions with a divergence of less than 0.5 mradians. The power consumption for the complete system should be under 25 watts. Low cost and high performance may be attainable by using a combination of commercially available components, cutting edge materials and technology, and innovative techniques.

PHASE I: Demonstrate the technical feasibility of developing a high performance compact infrared laser designator system that can be integrated with small UAVs. Develop an initial concept design capable of meeting UAV system and operational requirements.

PHASE II: Develop, construct, and demonstrate the operation of a high performance compact infrared laser designator prototype system. Complete the system design and if possible utilize commercially available components which meet military standard requirements.

PHASE III: Produce a suitable miniature laser designator for small UAVs. Install and perform validation and certification testing on the ScanEagle platform or other available similar UAV systems. Transition the technology to the fleet and provide a detailed supportability plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed low cost miniature illuminator has numerous potential commercial applications. This includes law enforcement, homeland security, surveillance, and search and rescue and any other application that requires low cost and compact IR illumination.

REFERENCES:
1. Adamy, David L., “A Second Course in Electronic Warfare”, Horizon House Publications, 2004.

2. Dickey, Fred M., Holswade, Scott C., “Laser Beam Shaping”, Marcel Dekker, 2000.

3. Winston, Roland, Minano, Juan C., Benitez, Pablo, “Nonimaging Optics”, Elsevier, 2005.

4. Schubert, Fred, “Light Emitting Diodes”, Carmbridge University Press, 2003.

KEYWORDS: unmanned aerial vehicles; laser designators; laser illumination; laser guided munitions; precision optics; solid-state IR laser

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-018 TITLE: <u>MH-60R Sonar NiCad Battery Reliability Improvement</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Electronics

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

OBJECTIVE: Develop alternate concepts to reduce manufacturing variability, improve reliability and extend the service life of multi-cell Nickel Cadmium (NiCad) rechargeable batteries.

DESCRIPTION: NiCad rechargeable batteries are commonplace in electrical power applications requiring high current drain, flat discharge characteristic, and rapid recharge cycle time. NiCad battery chemistry and associated technology are relatively mature. Cells in the most common standard commercial form factors are a commodity item.

Predicting NiCad cell life expectancy, especially in series-connected multi-cell battery arrays, is a major issue within embedded military applications. These applications are sensitive to product reliability under adverse conditions. Small intra-cell variations in charge storage capacity and internal resistance cause the battery to lose storage capacity with repeated charge cycles, especially in applications where the battery is seldom fully discharged. The problem worsens as the characteristics of individual cells in the battery diverge with repeated high-current charge cycles. Current cost to replace sonar system batteries is upwards of $450,000 each time. Moreover, poor battery reliability has significant intangible impacts to MH-60R fleet readiness as unit repair is a lengthy four to six month process during which the asset is unavailable to support a critical fleet undersea warfare mission. The costs and mission impacts of unreliable and short-lived NiCad cells are therefore of vital importance in this application. An improvement of 10% in the reliability and longevity of NiCad cells would yield large savings in Life Cycle Costs as well as markedly improve system availability. The cost savings and benefits realized in the target transition application alone will offset the SBIR technology investment many times over.

Innovative solutions are sought using either a single method or combination of methods, such as modification screening, improved power management, etc., to yield improved battery reliability and longevity. Possibilities include, but are not limited to, closer cell-to-cell uniformity, integral power management systems, and optimization of cell package construction that increase reliability and service life. Commercial NiCad "AA" cells are the target application for this effort. Techniques developed that could be equally applicable to NiCad batteries of other standard commercial form factors are preferred.

PHASE I: Design and develop concepts and methods for improving battery life expectancy and predictability. Demonstrate feasibility of the concepts developed.

PHASE II: Further develop and refine concepts and methods developed during Phase I. Demonstrate battery reliability, service life and predictability improvements through the development of a prototype system.

PHASE III: Develop a set of specifications, assembly instructions and recommendations demonstrably improving NiCad battery longevity and reliability in high-drain and frequent charge cycle applications such as the MH-60R sonar transducer. Transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications, such as satellites, remote sensing systems, and embedded industrial electronics, which frequently require high-reliability rechargeable power sources capable of high discharge rate and rapid recharge cycles under harsh service conditions and lengthy maintenance intervals.

REFERENCES:

1. "NiCd Technical Handbook," GPI International Ltd, 12 Nov. 2003, 18 Apr. 2009; http://www.gpbatteries.com.hk/html/pdf/NiCd.pdf

2. "NiCad Battery Apps. Manual," Eveready Battery Co, 6 Nov. 2001, 18 April 2009; http://data.energizer.com/PDFs/nickelcadmium_appman.pdf

3. Simpson, Chester. "Battery Charging," National Semiconductor 1995, 18 April 2009; http://www.national.com/appinfo/power/files/f7.pdf

4. "Inaccuracies of Estimating Remaining Cell Capacity with Voltage Measurements Alone," Maxim Application Note 121, Maxim Integrated Products, 23 Apr. 2001, 18 Apr. 2009; http://pdfserv.maxim-ic.com/en/an/AN121.pdf

KEYWORDS: battery; power management; reliability; embedded applications; longevity; manufacturing statistical process control

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-019 TITLE: Algorithms for Dynamic 4D (3D space with time) Volumetric Calculations and

Analysis

TECHNOLOGY AREAS: Information Systems, Electronics, Battlespace

ACQUISITION PROGRAM: Joint Strike Fighter

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OBJECTIVE: Develop an innovative software capability that can correctly and efficiently calculate the optimal flight path given the terrain data, aircraft position, flight characteristics, and positions of known threat emitters. Proposed solutions should identify required computer hardware configuration, third party tools, algorithms, and techniques. The software should execute within the mission planning timeline, and the developed algorithms should allow users to retrieve the data from the calculations to effectively place a sensor at the right place and at the right time to be effective.

DESCRIPTION: An optimal flight path is often required to maximize the effectiveness of a mission. This may, for example, include a flight path in which friendly forces are least vulnerable to hostile attack, or a flight path in which friendly forces can perform most efficiently given the known location of hostile resources and weapons. The basis for determining the best flight path is to evaluate the volume space as a function of time with respect to all known resources between the friendly and the hostile forces. The optimal path will be constrained by flight performance characteristics and will maximize the performance of the friendly forces.

Inputs to the algorithm would include threat emitter locations, weapon locations, aircraft position, and flight characteristics. The expected output would be a flight path that includes turnpoints, with specified time, speed, and course corrections.

The algorithm should consider:
- Terrain masking
- Volume (3-D space) analysis
- Alignment geometries
- Dynamic re-calculation

This effort should also include analysis tools that provide:
- 3D visualization of the volume space
- Playback or rehearsal along the flight path
- Graphical elements such as Line-of-Sight strobes
- Interactive user ability

The performance of this algorithm will be a critical factor given mission planning execution timelines. These timelines would be dependent on the density of calculation points, and will be specified.

PHASE I: Develop a proof of concept that identifies the techniques and algorithms that will be used, along with third party tools. The effort should identify the minimum computer hardware configuration required. Proof of concept should show that the performance requirements will be met.

PHASE II: Develop and demonstrate prototype software to meet the performance requirements.

PHASE III: Integrate software with existing systems, and extend software to improve capability based on realistic scenarios.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The tool has potential for all sensor and communications related applications involving calculation of optimal flight paths through dynamic volume spaces.

REFERENCES:

1. MATRIX Products. http://www.usna.edu/Users/oceano/pguth/website/so432web/e-text/GEODUC_book/Matrix%20Products_Ch_5.doc.

2. Bailey, C. "Department of Defense Usage of FalconView." http://www.blm.gov/pgdata/etc/medialib/blm/nifc/aviation/airspace.Par.77886.File.dat/FalconView.pdf.

KEYWORDS: 3D Visualization; Volume Space; Mission Planning; Electronic Attack; Optimal Flight Path Routing; Software Algorithms

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-020 TITLE: Multi-Channel Wideband Antenna Array Manifolds

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA-290, Maritime Patrol and Reconnaissance Aircraft

OBJECTIVE: Develop innovative array manifold design for reconfigurable multi-channel antenna arrays for radar, communications and electronic warfare.

DESCRIPTION: Most phase scanned arrays have limited bandwidth when they scan off axis. The greater the scan angle, the more the bandwidth is limited. For wide bandwidth applications, such as a synthetic aperture radar and inverse synthetic aperture radar modes, a 500 to over 1000 MHz wide band may have to be covered with three or more frequency overlapped pulses. The pulses are then combined in the frequency domain through signal processing to achieve the required resolution. This effectively reduces the pulse repetition frequency by a factor of three or more and requires extra processing, which could be avoided with some time delay compensation.

In addition to scan performance, accurate monopulse processing used in many modern radars, is required. These are all based on multiple channel systems. In a typical generic antenna topology the aperture is segmented in azimuth or elevation, or both and then combined either digitally or with analog combiners to form Sum, Delta Azimuth and Delta Elevation channels. This technique yields between 10:1 and 20:1 precision improvement over the beam width. A more flexible channel configuration is needed for when other modes are required in addition to air-to-air. For example if Ground Moving Target Indicator (GMTI) and Maritime Moving Target Indicator (MMTI) modes are also required, a more optimal manifold would support eight subarrays feeding a switchable manifold feeding three receivers. Such a configuration could include the possibility of a guard channel. Normally, the signal splits and switches would degrade the system noise figure to unacceptable levels. However, a key advantage of an Active Electronically Scanned Array (AESA) system is that the Low Noise Amplifier (LNA) is at the element where it sets the noise figure. The losses after the LNA do not significantly contribute to the noise figure. Signals can be split and switches can be used. Wide band multi-channel manifold research is needed to exploit the full capabilities of modern AESA based sensors.

The design should be capable of supporting a minimum bandwidth of 500 MHz. The manifold design should include the ability to support multiple subarray configurations to maximize performance of air-to-air and GMTI/MMTI modes along with a guard channel. The design should be of sufficient detail to allow an independent assessment of the design.

PHASE I: Develop and prove feasibility of a detailed conceptual design for a wide-band multi-channel manifold suitable for a candidate X or C-band array.

PHASE II: Utilizing Phase I design, assemble, test and demonstrate a prototype manifold capable of working with the candidate array. Investigate and define the packaging and I/O requirements to ensure suitability for transition of the design.

PHASE III: Transition the technology to the operational fleet and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High performance array manifolds are needed on a wide range of civilian and military sensor systems to support multiple surveillance requirements in a near simultaneous manner.

REFERENCES:

1. Alexopoulos, A., “Radar Systems Considerations for Phased Array Aperture Design Using Conformal Transformations on Riemannian Manifolds”, IEEE Transactions on Antennas and Propagation, 55(8), pp 2239-2246, August 2007.

2. Golio, John Michael, “The RF and Microwave Handbook”, Edition: 2, CRC Press, 2001.

3. Schreiner, M.; Leier, H.; Menzel, W.; Feldle, H.-P., “Architecture And Interconnect Technologies For A Novel Conformal Active Phased Array Radar Module”, Microwave Symposium Digest, 2003, IEEE MTT-S International, Volume 1, Issue , 8-13 June 2003 Page(s): 567 - 570 vol. 1.

KEYWORDS: Radar; Electronic Warfare; Array; Array Manifold; Multi-Channel; Multi-Mode

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-021 TITLE: Innovative Structures for Sonobuoy Applications

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: PMA-264; AIR ASW Systems

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OBJECTIVE: Develop lightweight, deployable and adaptable (smart) structures for "A" size sonobuoy components.

DESCRIPTION: The "A" size sonobuoy is a unique Anti-Submarine Warfare (ASW) sensor system: It is required to deliver acoustic detection and localization performance on a par with larger fixed and surface vessel mounted systems while being constrained by an expendable sensor budget. The "A" size sonobuoy volume and weight are limited by aircraft payload limitations and sonobuoys operate autonomously upon deployment from ASW aircraft. Because of these constraints great emphasis is placed on sonobuoy packaging efficiency and reliable deployment. This is particularly true when large planar or volumetric arrays need to be deployed to exploit performance gains achieved through array gain and beamforming techniques. These gains are further enhanced if the array geometry is adaptable to environmental or tactical conditions, i.e., the array can autonomously change shape in response to ASW operator commands or networked environmental sensor data.

Sonobuoy designers devote a great deal of effort to the design of acoustic sensor suspension systems. These systems attempt to isolate the sensors from in-situ ocean forces such as surface waves, internal waves and ocean currents. These forces can generate sensor motion modes which corrupt acoustic data and greatly limit sensor effectiveness.

Research over the past 40 years has resulted in the use of suspension components like mass-damper systems of elastic spring-like elements, large fabric surfaces designed to capture the hydrodynamic mass of the water in the vertical direction (damper disks) and large drogues in the horizontal direction. Despite the best efforts of sonobuoy designers, suspension components cannot be tuned to optimum performance in all conditions. A deployable drogue or damper disk that is capable of adapting its shape to changing conditions could greatly enhance the performance of sonobuoy systems.

PHASE I: Develop and demonstrate a design concept within the constraints of an "A" size sonobuoy by evaluating design feasibility and performance. Construct a detailed design of the "A" size package and deployed structure. Develop modeling and simulation of the structure including deployment and operational dynamics, shape control and structural loading. Determine performance gains associated with the use of this technology over existing systems.

PHASE II: Refine and develop Phase I candidate structure / concept. Fabricate an "A" size prototype of most promising concept and conduct laboratory testing of candidate hardware. Demonstrate system in an operationally relevant environment. Assemble Phase III plan for sonobuoy integration, air drop testing and certification.

PHASE III: Finalize a production design of Phase II prototype and apply the design to a specific sonobuoy suspension system. Integrate prototype system with sonobuoy hardware. Obtain air drop certification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed in this SBIR could be leveraged for other marine or space based systems that require adaptable, lightweight, strong, deployable systems. This could include satellite vehicle antenna or solar panel structures; oceanographic drifter buoy drogues or portable shelters that would adapt to the terrain or weather.

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1. Sherman, C.H., Butler, J.L. 2006. Transducers and Arrays for Underwater Sound. Springer Science+Business Media, LLC, New York.

2. Furuya, H., 1992. Concept of deployable tensegrity structures in space application. International Journal of Space Structures 7, pp. 143–151.

3. Pugh, A., 1976. An Introduction to Tensegrity, University of California Press, Berkeley, CA.

4. Skelton, R.E., Sultan, C., 1997. Controllable tensegrity, a new class of smart structures. SPIE, San Diego, pp. 12.

KEYWORDS: sonobuoy; tensegrity; array structure; damper; adaptable structure; shape control

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-022 TITLE: Antenna Placement Optimization on Large, Airborne, Naval Platforms

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290, Maritime Patrol and Reconnaissance Aircraft; PMA-265, Super Hornet

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Port highly developed, high-frequency, serial antenna analysis codes to latest technology computer clusters in order to significantly reduce time in analyzing on-platform antenna performance and antenna-to-antenna interaction.

DESCRIPTION: Modern naval aircraft can be large in dimensions and may carry a large number of antennas. A good example is the Navy's P-8A Poseidon aircraft [1], a Boeing 737 that is roughly 40 meters long and has a wingspan of about 34 meters. This aircraft carries over 100 antenna systems. For many of these systems, the surface area of the platform is in the tens of thousands of square wavelengths. In this case, the use of full-wave solvers to assess the on-platform performance of an antenna or the interaction between two antennas is impractical, both in terms of computing resources required and length of execution time. The next best choice is to use a high-frequency code. Although not as accurate as full-wave codes, high-frequency codes require modest computer resources and are faster than full-wave codes. In a serial mode, however, even these codes can take substantial time to execute depending on platform size and complexity. This is especially true when considering the on-platform coupling between two antennas if there is a large number of two-antenna combinations. If we are to optimize antenna performance and minimize its interaction with a number of other antennas, then the most cost-effective way to proceed is to port serial, high-frequency codes to clusters of parallel computers. This will improve execution time by orders of magnitude, thus reducing idle time and lost momentum in the workplace.

High-frequency codes are ideally suited to parallelization. The hardware for such an effort can be a traditional central processing unit (CPU) cluster [2] or a graphics processing unit (GPU) cluster [3]. We are favoring the GPU solution both because of the Flops/dollar advantage and because of the recent introduction of compute unified device architecture (CUDA) [4], a language that greatly facilitates programming a GPU. Researchers are already using GPU clusters for a variety of problems [5] and GPU-based hardware is already in the marketplace [6]. We are also interested in CPU clusters since we already own one. With the above in mind, we are seeking innovative solutions for porting high-frequency computational electromagnetic codes to both CPU and GPU-based parallel environments for the purpose of greatly accelerating their performance. These codes must have the capability of assessing antenna performance on large and complex platforms; they also must be able to handle in-situ coupling between antennas; additionally, it is highly desirable that they have a radar cross-section (RCS) calculation capability. Small businesses must clearly demonstrate the capabilities of their high-frequency code in their proposal. They should also have an understanding of GPUs and CUDA and be prepared to work in both a CPU and a GPU environment. Previous experience in programming GPUs is highly desirable. Teaming between electromagnetics and computer experts is also encouraged.

PHASE I: Develop a detailed description of the algorithms from an existing high-frequency solver that would need to be modified to run on a CPU and a GPU-based parallel computing architecture. Identify existing algorithms that may be problematic in transferring to a parallel environment and suggest modifications. Identify existing algorithms that can be improved upon to provide better answers, modify accordingly and test. Perform a study to estimate whether porting the code to both types of environments is feasible within the Phase II timeframe. Develop specifications for a GPU cluster and perform a market search for cluster. Develop a Phase II implementation plan for a CPU and a GPU cluster. Identify other hardware acceleration techniques that could potentially be developed during the Phase II effort.

PHASE II: Purchase test-size GPU cluster identified in Phase I. Use it and existing NAVAIR CPU cluster to port the algorithms identified in Phase I. Validate successful implementation of the parallelization through timing and accuracy studies on electrically very large problems. Ensure that the resulting algorithms are scalable with increasing number of processors. Deliver, install, and provide training for the parallelized high-frequency solver to NAVAIR along with thorough documentation. If NAVAIR is interested in other hardware acceleration techniques identified during Phase I, implement prototype capabilities during the Phase II effort.

PHASE III: Deliver, install, and provide training for the parallelized high-frequency solver to NAVAIR along with thorough documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic can be used in the commercial communications industry, including antenna design and placement, platform integration, electromagnetic compatibility (EMC) and electromagnetic interference (EMI).

REFERENCES:
1. http://www.boeing.com/defense-space/military/p8a/index.html

2. http://en.wikipedia.org/wiki/Computer_cluster

3. http://www.gpgpu.org/

4. http://www.nvidia.com/object/cuda_home.html

5. http://www.cs.sunysb.edu/~vislab/projects/urbansecurity/GPUcluster_SC2004.pdf

6. http://www.amax.com/TeslaPSC-1.asp?gclid=CNKc6M-Qh5kCFQwNGgodn0iemg

KEYWORDS: Antenna Simulations; Computer Clusters; High-Frequency Electromagnetics; Computer Gpus; Hardware Acceleration; Electrically Large Platforms

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-023 TITLE: Processor Architectures for Multi-Mode Multi-Sensor Signal Processing

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA-290, Maritime Patrol and Reconnaissance Aircraft

OBJECTIVE: Develop innovative processor architectures for multi-mode radars and fusion with other sensors for automatic target recognition.

DESCRIPTION: The DoD has made major investments in the development of Active Electronically Scanned Array (AESA) radar technology that provide enhancements in beam agility and provide for near simultaneous multi-mode operation. The full exploitation of these capabilities, when considering Pulse Mode Interleaving (PMI), present processing architecture challenges. The processing architectures must be able to accommodate adaptation to the scenario and environment. In addition, recognition algorithms that exploit Inverse Synthetic Aperture Radar (ISAR) and Infrared (IR) imagery may require significantly more and different processing capabilities to be automated to the level required to relieve operator workload.

Driven by the commercial graphics and gaming industry, a new class of general purpose graphics processors units (GPGPU) and many core processing architectures are now available for power, cost and weight constrained DoD platforms. For data intensive parallel signal processing applications, computational performance improvements of 10x to 100x over current digital signal processing (DSP) implementations are achievable. In addition, these new commercial off the shelf (COTS) architectures provide low cost, high through-put/watt efficiency, and high productivity programming. While this type of processor has been available for several years, only in the last two years has high level language software development been possible. The continued development of graphics processor architectures are expected to endure as the graphics industry and the core processor industry continues to evolve to meet commercial market demands in mobile video and gaming. The suitability of GPGPU based processing for a wide range of radar applications is an open question. The specific implementation method can dramatically impact overall processing speed.

The primary goal of this effort is to understand how to optimally utilize GPGPU processing to dramatically increase the overall computational speed of radar based target recognition algorithms utilizing moving target indicator, high range resolution and imaging modes.

PHASE I: Design and demonstrate feasibility of processor architectures that enable AESA exploitation and automatic target recognition. Develop an RDT&E plan addressing performance metrics.

PHASE II: Using the concept developed in Phase I, evolve the processor architecture design and demonstrate key aspects and performance metrics.

PHASE III: Finalize the technology and in conjunction with radar system manufacturers, transition to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The general methods developed could be applicable to a wide range of feature classification needs ranging from those of homeland security to the medical field.

REFERENCES:

1. Georgia Institute of Technology; Programming tools facilitate use of video game processors for defense needs; http://www.physorg.com/news165059236.html

2. Georgia Tech Research Institute; Inexpensive Parallel Processing: Programming Tools Facilitate Use of Video Game Processors for Defense Needs; http://www.gtri.gatech.edu/news/programming-tools-facilitate-use-video-game-process

3. Shuai Che, Michael Boyer, Jiayuan Meng, David Tarjan, Jeremy W. Sheaffer, Kevin Skadron. A Performance Study of General-Purpose Applications on Graphics Processors Using CUDA. http://www.cs.virginia.edu/~skadron/Papers/cuda_jpdc08.pdf

KEYWORDS: inverse synthetic aperture radar; automatic target recognition; ship and small craft classification; data fusion; multi-mode radar; general purpose graphics processors units

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-024 TITLE: Winch Gearbox Prognostics & Health Management

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-299, H-60 Helicopter Program; Sea Shield

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OBJECTIVE: Develop and demonstrate a Winch Gearbox Prognostics & Health Management System suitable for utility applications in a modern rotary wing aircraft.

DESCRIPTION: Modern rotary wing aircraft have a number of utility winching/reeling systems for cargo, rescue, and sensor deployment applications. On the H-60, examples include the Airborne Mine Countermeasures – Carriage, Stream, Tow, and Recovery System (AMCM CSTRS) Winch System, rescue hoist, and the Airborne Low Frequency Sonar (ALFS). Unexpected degradation or failure of these systems can cause serious mission, reliability, maintenance, and logistical impact.

A Winch Gearbox Prognostics & Health Management System could increase reliability and mission availability by accurately determining which parts are showing initial signs of failure, but remain usable to perform a mission with some degree of confidence for a predicted amount of time. This system should detect signs of degradation or failure precursors through advanced sensing techniques, integrated through software and predictive algorithms, and have available displays to both the user/winch operator and maintenance personnel. Displays or alerts identifying specific failure conditions and remaining life until maintenance is required, are desirable. The system needs to be lightweight, easily maintainable in and of itself, have a small footprint, and require minimal power interface with existing aircraft systems (a self-powered, wireless system of sensors would be preferable but is not mandatory). The system should be easily retrofitted to existing winch gearbox designs and existing H-60 Health & Usage Monitoring System (HUMS) Although there are some Rotary Wing Propulsion Gearbox systems that utilize HUMS technology very effectively, they do not cover the larger suite of potential degraders and Prognostics & Health Management goals intended to be accomplished here, especially on utility-type gearbox units.

Potential areas for sensor development include but are not limited to: Lubricant quality/quantity detection, Signs of Gear mechanical component wear indication (wear particles in oil, etc.), Gearbox temperature and its rate of change, Gearbox vibration, Increase in Gear tooth backlash/chatter, Seal integrity and Detection of Lubricant leakage and/or rate of change of leakage.

The challenge is to design and test a Winch Gearbox Prognostics & Health Management System that incorporates integral electronics capable of providing reliable operation in a difficult thermal, vibration and potentially corrosive maritime environment. As the goal is to develop a generally applicable Winch Gearbox Prognostics & Health Management System technique and system, no specific target Winch Gearbox is identified.

PHASE I: Identify and develop a design for a Winch Gearbox Prognostics & Health Management System. Determine the feasibility of such a design by analyzing functionality and suitability for relevant aircraft applications.

PHASE II: Develop, demonstrate and validate the Winch Gearbox Prognostics & Health Management System. Conduct performance and qualification-type tests with and without pre-planned failure modes to verify the system developed in Phase I accurately identifies failure causes/modes. Evaluate and modify the design to address any shortcomings found in testing.

PHASE III: Transition the design to applicable platforms that can utilize a Winch Gearbox Prognostics & Health Management System.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The Winch Gearbox Prognostics & Health Management System would have direct application to Winching/Reeling systems on commercial aircraft such as Search & Rescue aircraft, Police/Security helicopters, Logging Operation Aircraft, and Off-Shore Oil Rig aircraft operation. Other potential applications include industrial control and heavy equipment used in construction and mining operations. Indirect application of the technology to other non-winch gearbox systems appears feasible, and could be even broader to perhaps encompass commercial aircraft utility systems of many types as well as Propulsion Gearbox Prognostics & Health Management with capabilities above those of current HUMS-type systems.

REFERENCES:
1. Fraser, K.F., “An Overview of Health and Usage Monitoring Systems (HUMS) for Military Helicopters”, September 1994, http://dspace.dsto.defence.gov.au/dspace/bitstream/1947/3936/1/DSTO-TR-0061%20PR.pdf

2. Ousachi, Mark; Scott, Andrew; Yee, David; Hosmer, Thomas; Daniszewski, Dave; ASCTI, Troy, MI; “Embedded Diagnostics and Prognostics Wireless Sensing Platforms”; http://www.stormingmedia.us/86/8673/A867344.html

3. Raytheon Company, “AN/AQS-22 ALFS, Airborne Frequency Sonar”; http://www.raytheon.com/businesses/rids/products/rtnwcm/groups/public/documents/content/rtn_bus_ids_prod_anaqs22_pdf.pdf

KEYWORDS: Winch; Gearbox; Prognostics; Health Management; Failure Prediction; Gear Wear

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-025 TITLE: Improved Antisubmarine Warfare (ASW) Sonobuoy Location Technique in a Denied Global Positioning System (GPS) Environment

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: Advanced Extended Echo Ranging (AEER) ACAT IV; PMA-264, Air ASW Systems

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OBJECTIVE: Develop an innovative sonobuoy location system that can operate at any altitude when the ASW platform is operating in a denied Global Positioning System (GPS) environment.

DESCRIPTION: This topic addresses the situation where GPS information is denied either by design or by other means. Currently there are only two location systems available when the ASW platform is operating in a denied GPS environment, an On-Top Position Indicator (OTPI) and a sonobuoy positioning system (SPS). Both of these systems have deficiencies. The OTPI is a Very High Frequency (VHF) directional finder system that is susceptible to Radio Frequency Interference (RFI) and has unacceptable errors at high altitude. The SPS is a new sonobuoy location system that surveys the Radio Frequency (RF) levels for deployed sonobuoys and determines their location.

The need to accurately locate deployed sonobuoys that generate areas of probability (AOP) or estimated positions (EP) is paramount to final contact localization in order to meet attack criteria when directed. New active and passive multi-static sonobuoys will, in the near future, contain course/acquisition (C/A) type GPS units to meet this requirement. P-coded GPS will not be an option for the expendable sensors. New ASW platforms will operate at much higher operational altitudes requiring the proposed system be capable of operating at any ASW platform altitude.

The proposed system can be either active or passive in nature and the radio frequency spectrum under consideration is from 10^4Hz though 10^{22}Hz.

PHASE I: Develop a concept and determine the feasibility of developing a sonobuoy location system that will operate at any altitude when the ASW platform is operating in a denied GPS environment.

PHASE II: Develop and demonstrate a prototype based on the Phase I design and define volume, power requirements, and unit cost.

PHASE III: Coordinate with Navy AN/SSQ-53F sonobuoy manufacturers to transition the new technology into the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The use of this technology could be used for Sea/Land rescue by first responders.

REFERENCES:
1. Personal Dead-reckoning System for GPS-denied Environments, http://www-personal.umich.edu/~johannb/Papers/paper142.pdf

2. Personnel Tracking in GPS-Denied Environments Using Low Cost IMUs, www.geonav.ensco.com

KEYWORDS: Sonobuoy; Radar; GPS-Denied Navigation; Localization; Inertial Measurement Unit (IMU); HAASW

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-026 TITLE: Multi-Axis Vibration Mitigation and Habitability Improvement for Seated Occupants

TECHNOLOGY AREAS: Materials/Processes, Human Systems

ACQUISITION PROGRAM: PMA-231, E-2 Hawkeye Program Office; FNC - Force Health Protection

OBJECTIVE: Develop innovative solutions for reducing high-frequency vibratory input to seated occupants performing missions on board propeller driven aircraft.

DESCRIPTION: The E-2C Hawkeye is the Navy's all-weather airborne early warning and command and control aircraft for carrier battle groups. The E-2C also conducts missions that include surface surveillance coordination, strike and interceptor control, search and rescue guidance and communications relay functions. As the aircraft capability has been upgraded and mission lengths extended, there have been increasing complaints of annoyance, fatigue, and musculoskeletal pain during prolonged exposures to propulsion-generated vibration in this propeller-driven aircraft. Air Force studies have indicated that the introduction of a cushion alone may be insufficient to mitigate the full range of vibration felt by E-2C and other propeller-driven aircraft occupants.

Acute pain and discomfort amongst E-2C aircrew are most likely attributable to several factors such as poor posture, seating ergonomics, vibration of the aircraft during flight, and total number of flight hours. However, the work sought here centers around design concepts for reducing multi-axis whole-body vibratory input to seated occupants and for enhancements to seat that improve the aviators/operators ability to conduct long missions without developing numbness and pain in the back and legs.

Proposed concepts should:

- not cause a substantial increase in weight of the seating system;
- be retrofittable into the airframe without aircraft modifications;
- enhance crash performance and occupant protection;
- incorporate or develop materials that eliminate or reduce pressure points on the legs and impingements on the back;
- be compatible with aviator/operator body-borne mission equipment.

The E-2C has crew stations that are both parallel to the longitudinal axis of the aircraft (pilot/copilot) and perpendicular to the aircraft's longitudinal axis (Naval Flight Officers). All seating stations are floor-mounted to tracks and have the capability to adjust vertically and fore/aft. Acceptable design concepts must take each of these seating orientations into account.

Concepts must demonstrate a reasonable likelihood of reducing total vibratory input delivered to the seated occupant and of increasing overall habitability for extended missions lasting up to 7 hours. Candidate system weight, complexity, reliability, maintainability, and effectiveness will be very important factors in selecting a candidate system.

PHASE I: Demonstrate feasibility of proposed cocept to reduce high-frequency vibratory input transmitted to seated occupants on board the E-2C and of improve seat habitability by reducing "hot spots" on the seat bottom and back cushion.

PHASE II: Develop and demonstrate prototype system. Based on the outcome of laboratory testing, perform refinements to the prototype system aimed at improving system performance.

PHASE III: Fabricate production representative seating systems or integrate the recommended solutions onto the existing seat depending on the design concept. Support qualification and flight demonstration testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a need for implementation of vibration mitigating seating systems for civil aircraft. Military development of seating systems that significantly reduce whole-body vibration transmitted to seated occupants will likely result in an acceleration of implementation of these systems into civil aircraft.

REFERENCES:

1. Smith, S.D., Smith, J.A., (2005). Multi-axis vibration mitigation properties of seat cushions during military propeller aircraft operational exposures. AFRL/WS-05-2250.

2. Loomis, T.A., Hodgon, J.A., Hervig, L., and Prusaczyck, W.K. (1999). Neck and back pain in E-2C Hawkeye aircrew. Technical Report 99-12, Naval Health Center.

3. Testerman, R., Howell, H., Rudy, M., (2006). Final report for seating study completed on E-2C Aircraft (Unpublished).
Note: Reference #3 has not been released for public distribution. However, you can submit a request to Naval Air Systems Command, 47123 Buse Road, Patuxent River, MD 20670-1547.

4. International Standard 2631-1, 1997-07-15, Mechanical vibration and shock -Evaluation of human exposure to whole-body vibration - Part 1: General requirements.

5. E2 Seat Photo (uploaded in SITIS 12/7/09).

6. Drawing, PSE dimensions, uploaded in SITIS 12/08/09.

KEYWORDS: whole-body vibration; aircrew seating; fatigue; back pain; numbness; vibration mitigation

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-027 TITLE: Universal Switching Across Automatic Test Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMA-260, Aviation Support Equipment Program Office

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OBJECTIVE: Develop a universal switching strategy that will unify signal routing information for differing Automatic Test System (ATS) architectures into abstractions that provide a common understanding of function and purpose.

DESCRIPTION: A key element of various test systems is switching management. Many systems employ various forms of switching that must be allocated. The switching architectures and implementations are widely various in format and capability. Electronic architectures that are facilitated with multiple path connection possibilities often could be designed in a more flexible and fault tolerant way if a well based model, and deployment scheme for the model, are widely accepted. Often there are cases where developers use prior knowledge of the system’s specific locations to design switching networks. To enhance designs, inject more flexibility, and achieve more error tolerance, a technology with the ability to actively route, allocate and generally abstract the switching designs from hard wire instantiations is needed. DoD testers could benefit from incorporating standardized switching strategies and technologies. Incorporation of these prospective technologies would enhance TPS interoperability between systems of varying architectures, thereby promoting life cycle cost reduction.

Two elements in the DoD's ATS Framework, which have not yet been completed are Resource Management Services (RMS) and Resource Adapter Information (RAI). A predominant feature that these elements must support is a method to facilitate universal switching. Currently there is no abstraction for switching implementation in the industry or the standards community. Satisfactorily providing the DoD ATS Framework with components and standards that can support this needed key area will promote the strategy and provide cost savings in future systems that employ it.

PHASE I: Demonstrate the feasibility of proposed universal switching concepts that will work across Navy and DoD automated test systems.

PHASE II: Based on Phase I modeling, develop a prototype and performance criteria for evaluation. Demonstrate and validate the concept by developing a complete prototype that is integrated on an existing system. Analyze and detail the technical merit of the prototype based on the DoD ATS Framework elements and the DoD system identified.

PHASE III: Provide a mechanism for incorporating the universal switching technologies into a broad range of potential electronic systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: All commercial industries that utilize ATS will benefit from this technology, in particular, airlines, automotive, and medical.

REFERENCES:
1. Rowe, Martin. "Avoid Switching Mistake". Test & Measurement Magazine, September 2007. http://www.tmworld.com/article/CA6473099.html.

2. Wag, Francis C. "A Guide to DFT and Other Techniques". IEEE, Published by Academic Press, 1991, ISBN 0127345809, 9780127345802

3. The DoD Automatic Test System Framework Roadmap; http://www.acq.osd.mil/ats/

KEYWORDS: Switch; Resource Management; Architecture; Interoperability; Ontology; Automatic Test System

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-028 TITLE: <u>Computational Characterization of Aeroengine Combustor/Augmentor Fuel Injectors</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop advanced computational methodologies and technologies for detailed simulation and characterization of aeroengine combustor/ augmentor fuel injector performance.

DESCRIPTION: Aeroengine combustor/augmentor performance (stability, efficiency, durability and emissions) is critically dependent on the details of fuel injection and atomization. Quantification and/or prediction of fuel atomization are still at relatively primitive levels, particularly when compared to other reacting flow phenomena occurring in these devices. This is due to the complexity of the two-phase flow physics and the geometrical complexity of injectors as well as the inherent limitations in experimental measurement in the vicinity of the atomizing fuel. Recent advancements in numerical methods and increases in computational power have presented computational simulation as a viable alternative to traditional approaches in the quantification of fuel atomization.

An innovative solution is sought to advance the capabilities and transition numerical/computational technologies towards the simulation of injectors operating under realistic conditions. The benefit of such simulations will be utilized to reduce the number of experiments while improving injector design and/or improving the fidelity of the models. The developed computational methodologies need to be able to reproduce fuel atomization in geometrically complex injectors that employ aerodynamic forces to atomize the fuel. Such atomization is very complex and includes the evolution and breakup of contiguous liquid fuel, dense spray dynamics, spray wall interactions, and disperse phase dynamics in a high Reynolds number vortical flow. In addition, for aeroengine combustor/augmentor applications these phenomena occur over a range of global pressures and temperatures and may be further complicated by the use of alternative fuels.

The computational model is to be sensitive to geometric, fuel type and operating condition changes and be able to reproduce the injector internal and external two phase flow. Atomization must be due to aerodynamic breakup and should include spray-wall interaction.

PHASE I: Design and demonstrate the feasibility of an innovative spray atomization computational technology. Identify and formulate the computational technologies that need to be developed to achieve the injector characterization.

PHASE II: Further develop the injector characterization computational technology. Validate prototype with far field measurements. Demonstrate the prototype for at least two relevant injectors.

PHASE III: Finalize the technology and transition to the appropriate engine platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of the advanced computational methodologies and models that can predict fuel injector performance should enable engineers to enhance injector design and improve the performance, operability and durability of combustion devices relevant to tactical and commercial transport aircraft. This is particularly important for improved fuel economy and range of these platforms.

REFERENCES:
1. Ménard, T, Tanguy, S., Berlemont, A., “Coupling Level Set/VOF/Ghost Fluid Methods: Validation and Application to 3D Simulation of the Primary Break-up of a Liquid Jet,” Inter. J. of Multiphase Flow, v. 33, 510-524 (2007)

2. Gorokhovski, M. and Herrmann, M., "Modeling Primary Atomization", Annual Review of Fluid Mechanics. Volume 40, Page 343-366, Jan 2008

3. Arienti, M. and Soteriou, M.C., "Dynamics of Pulsed Jet in Crossflow" GT2007-27816, Proceedings of ASME Turbo Expo 2007

4. Inoue, C. , Watanabe T. and Himeno T., “Study on Atomization Process of Liquid Sheet Formed by Impinging Jets” AIAA-2008-4847

5. Liovic, P., Lakehal, D., "Multi-physics treatment in the vicinity of arbitrarily deformable gas–liquid interfaces," Journal of Computational Physics 222 (2007) 504–53

6. Ohta, S. and A. Matsuo, Horikawa, A., “Numerical And Experimental Investigations on Atomization of Air-blasted Liquid Film”, AIAA-2009-0997

KEYWORDS: Combustor Spray M&S; Augmentor Spray M&S; CFD; VAATE; Atomization; Gas Turbine Engine

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-029 TITLE: Automated Generation of Advanced Test Diagrams to Reduce Test Program Set

Life-Cycle Costs

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMA-260, Aviation Support Equipment Program Office

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TITLE: Automated Generation of Advanced Avionics Test Wiring Diagrams to Reduce Avionics Test Program Set Life-Cycle Costs

OBJECTIVE: Develop an automated solution to generate advanced test wiring diagrams to support Test Program Sets (TPSs) for avionics that allows for the inclusion of electrical signal data in the test diagram.

DESCRIPTION: Test wiring diagrams are an important feature for avionics TPS support and are useful throughout the TPS life cycle. They are used as a guide in troubleshooting the TPS and avionics Automatic Test System (ATS) when tests fail to run properly, can be a key factor in ensuring the ATS are ready to support the weapon system, and can be used to determine how a TPS can be re-hosted on other ATS. Test wiring diagrams provide the active wire path information for stimulus and measurement signals from the ATS instruments to the avionics unit under test (UUT) for each test in the program. Typically, test wiring diagram generation requires extensive manual analysis of test program source code, interface hardware, and test station capabilities. An automated process should significantly reduce the time to generate test wiring diagrams, increase the accuracy of test diagrams, ensure consistency between test diagrams and modified TPSs, and use an open systems approach relying on IEEE automatic test markup language (ATML) standards for data formats.

Typically, test wiring diagrams are created after the avionics test program is integrated onto the ATS and the TPS software and hardware are completed. These diagrams show TPS developers and maintainers the paths that electrical currents flow through the wires and switches in the Interconnect Device (ID) and the ATS so that complete paths can be shown from the UUT to the ATS instruments. With the proposed automated process, the advanced test wiring diagrams can be generated during TPS development and can be used to assist in the integration of the TPS. The additional signal description information, not present in typical test diagrams, can greatly enhance the troubleshooting process. These concepts can result in decreasing the TPS development time. Additionally, the reliance on an extensive manual process often hinders the updating of test diagrams when the TPSs are modified, due to either new versions of the UUTs or changes in test station instrumentation. This results in the test diagrams quickly becoming outdated and of little value in understanding the electrical currents and signals flowing between the UUT and the ID/ATS to effectively diagnose problems in the UUT. The automation of test diagrams ensures that the diagrams are always consistent with the test program.

The proposed approach for the description of the test station and interface adapter hardware should be based on the IEEE 1671 ATML standards. Using a standard data format will make this process easily transportable to other test station platforms. An automated advanced test diagram generation system used on a DoD ATS station such as the Consolidated Automated Support System (CASS) and require a minimum of TPS knowledge to operate, is desirable.

PHASE I: Determine the feasibility of automatically generating avionics test wiring diagrams that support avionics TPSs. Determine how the current test wiring diagrams can be augmented to include stimulus and measurement signal information.

PHASE II: Develop a complete set of prototype tools that will automatically generate advanced test wiring diagrams. These will include ATML test station and ATML test adapter instance documents, the test program signal extraction software, and the automatic test diagram generation software. Demonstrate and validate the prototype software to generate ATML instance documents using a DoD TPS as the target.

PHASE III: Transition the software tools and processes to DoD ATS programs such as CASS.

PRIVATE SECTOR COMMERCIAL POTENTIAL The need for improvement of avionics test program support in ATS is common throughout the DoD and commercial industry, as is the pressure of reduced budgets. The similarities in ATS and TPS development applications allows for leveraging of solutions across the DoD and industry. Specific commercial applications include the airline, medical, and automotive industries.

REFERENCES:

1. The DoD Automatic Test System Framework Roadmap; http://www.acq.osd.mil/ats/

2. Automatic Test Markup Language IEEE STD1671; http://standards.ieee.org/

KEYWORDS: Automatic Test Systems; Test Diagrams; DoD ATS Framework Working Group; Test Program Set; Automatic Test Markup Language; Interoperability

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-030 TITLE: Lossless Non-Blocking Single-Mode Fiber Optic Wavelength Router

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: Joint Strike Fighter

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OBJECTIVE: Develop a scalable and virtual non-blocking avionics wavelength-division multiplexer (WDM) fiber optic local area network wavelength router.

DESCRIPTION: Fiber optic networks in aircraft are becoming a reality whereby fiber based backplane switch or ring fabrics serve as a basic foundation for high speed data intercommunication paths onboard aerospace platforms. A current practice is to overlay high speed fiber optic sub-networks and point-to-point links independently from lower speed copper-based electrical buses and other individual point-to-point electrical links in federated avionics architecture with associated size, weight, cooling, installation and cost penalties. Another approach, the integrated modular architecture (IMA), provides an improvement over the federated architecture by sharing computing resources while still giving proper spatial and temporal partitioning to ensure protection against fault propagation, but does not provide a fully-networked avionics architecture. This project seeks the use of forward-looking wavelength division multiplexing photonics technology such as tunable wavelength converters and lossless wavelength add/drop multiplexing filters to create a unified, protocol-independent WDM LAN wavelength router that supersedes current federated and IMA approaches by enabling a fully-networked integrated avionics architecture. Desirable features are packaging compactness (no greater than 500 in3), packaging ruggedness per MIL-STD-810F, minimal power consumption (no greater than 100 Watts), re-configurability, transparency, predictable latency (real time), resilience, scalability, reliability via integration, and built-in test in the harsh avionics environment.

Selection criteria for the router design should be based on characteristics of non-blocking WDM LAN architectures for transferring data and video information between distributed avionics sub-networks and subsystems (scalable between 8 and 16 sub-networks) onboard aerospace platforms. Design modeling should be applied to capture the optical node behavior of the router. Following node design and modeling and simulation, proof-of-concept hardware prototypes should be fabricated and tested against probable realistic integrated avionics sub-network integration architecture and data fusion implementations. Component selection criteria should maximize the use of digital photonic device and hybrid optoelectronic packaging integration to minimize size, weight and power consumption and maximize reliability and manufacturability.

PHASE I: Develop a bi-directional WDM LAN router concept and demonstrate via modeling and simulation. Prove baseline router topology and physical implementation concept.

PHASE II: Develop, build, test, and demonstrate a prototype router based on next generation digital avionics network traffic control and data transmission and reception requirements. Test and validate.

PHASE III: Ruggedize packaging and test router over the full avionics operational environment. Transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Could be used in commercial telecom central offices and datacom computer local area network sites to increase capacity and throughput.

REFERENCES:
1. Watkins, C.B. and Walter, R., “Transitioning from federated avionics architectures to integrated modular avionics,” Proceedings IEEE/AIAA 26th Digital Avionics Systems Conference, pp. 2.A.1-1-2.A.1-10, 2007..

2. Jessop, C.N., Jenkins, R.B., and Voigt, R.J., “Routing in an optical network using wavelength conversion,” IEEE Avionics Fiber Optics and Photonics Conference Proceedings, pp. 24-25, 2006.

3. Braun, S. and Xeujung, M.M., “Advanced optical network,” IEEE Aerospace Conference, 2006.

4. Kumar, A., Sivakumar, M., Stringer-Blaschke, M.T. and McNair, J.Y., “Priority-based ring-hybrid WDM LANs for avionics,” IEEE Avionics Fiber Optics and Photonics Conference Proceedings, pp. 58-59, 2007.

5. Jenkins, R.B and Voigt, R.J., “Demonstration of bidirectional add drop multiplexers and mixed signals in a DWDM mesh architecture,” European Conference on Optical Communications (ECOC) Proceedings, 2008.

KEYWORDS: Avionics; Fiber Optics; Networks; Wavelength Division Multiplexer (WDM); Router; Optoelectronic Packaging

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-031 TITLE: Non-Flammable Electrolyte for Naval Aviation Lithium Batteries

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I, PMA-276, H-1 Light Attack Helicopter Program

OBJECTIVE: Develop a non-flammable electrolyte to significantly increase the safety and reliability of Lithium batteries used on Navy aircraft.

DESCRIPTION: Increased demand of mission requirements placed on Navy aircraft and other military applications have necessitated high energy and high power storage systems capable of operating over a broad temperature range. High energy Lithium battery systems have proven themselves in many military, commercial and aerospace applications, and present programs are underway to develop high energy Lithium batteries for Navy aircraft.

However, present Lithium batteries use electrolytes incorporating a Lithium salt in an organic solvent. When overheated due to overcharging, internal shorting, manufacturing defects, physical damage, or other failure mechanisms, such electrolytes have the disadvantage of high flammability, releasing highly toxic chemicals when combusted. Eliminating all failure mechanisms that lead to overheating would be difficult and expensive due to the complex operational environment of naval aircraft. Although current investigations are underway to develop Lithium battery cathode materials that do not supply oxygen to feed fires, and anode materials that do not generate excessive heat and provide the “spark” that ignites combustion, the flammability of the electrolyte is the one part of the system that has not been addressed. The development of an innovative low-cost non-flammable electrolyte will greatly improve the safety and reliability of Lithium batteries used on Navy aircraft.

The developed non-flammable electrolyte composition is to be incorporated into a complete battery system, maintaining or improving the performance of present Lithium battery technology. These performance parameters include the following: high gravimetric power density (up to 6000 W/kg), quick recharge capability (<10 minutes to recharge fully depleted cell), good cycle life (> 5,000 cycles at 100% depth of discharge), long calendar life (>5 years service and storage life), and functionality and stability over a wide temperature range (-40°C to +80°C). The battery system utilizing the non-flammable electrolyte should also meet the requirements of the cycling test detailed in MIL-PRF-29595A.

PHASE I: Demonstrate feasibility of proposed non-flammable electrolyte replacement for use in Lithium batteries. Proof-of-concept should include benefits of non-flammable electrolyte compositions, manufacturing capabilities, and cost estimates.

PHASE II: Develop, build and demonstrate a prototype non-flammable electrolyte Lithium battery system. Perform functional test and evaluation. A successful prototype demonstration must meet Naval Aviation battery requirements.

PHASE III: Integrate non-flammable electrolyte Lithium battery into Navy aircraft power system including ground and flight demonstrations. Work with weapon system contractor to transition technology across naval platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The results of this work can be directly applied to provide Lithium-ion batteries with non-flammable electrolyte for use on commercial aviation applications.

REFERENCES:
1. "Navy Lithium Fire Fighting Recommendations", D. Fuentevilla, J. Banner, A. Suggs, Proceedings of the 43rd Power Sources Conference, July 7-10, 2008, Philadelphia, Pennsylvania.

2. "Safety Issue and Its Solution of Lithium-ion Batteries", S. Zhang, D. Foster, J. Wolfenstine, J. Read, Proceedings of the 43rd Power Sources Conference, July 7-10, 2008, Philadelphia, Pennsylvania.
Copies of references listed above can be obtained through National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161-0001, http://www.ntis.gov.

3. MIL-B-29595, "Batteries and Cells, Lithium, Aircraft, General Specification For" Military Specification, 29 June 2000.

KEYWORDS: Battery Systems; Lithium; Electrical Systems; Energy Storage; Aviation; Electrolyte

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-032 TITLE: Automated Sense and Avoid for Due Regard

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-262, Persistent Maritime Unmanned Aircraft Systems; PMA-266

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OBJECTIVE: Develop an autonomous sense and avoid capability for Unmanned Aerial Systems (UAS) operating in the National Air Space (NAS) and in theater.

DESCRIPTION: UASs do not have the ability to exercise due regard in a mixed unmanned/manned aircraft environment since they lack an autonomous sense and avoid capability. The Department of Navy, other government agencies and private ventures are in the process of integrating UASs into the NAS. Therefore, there is a need to develop an innovative system applicable to both manned and unmanned aviation that can help identify no-fly zones, predicted flight trajectories (powered and unpowered), automated manned/unmanned separation criteria, and early warnings of predicted collisions to pilots, operators, and controllers. This would help in gaining confidence in range safety procedures, flights over populated areas, and teamed flights with manned aircraft. This is also required for the Navy's air launch Unmanned Aerial Vehicle (UAV) concepts to ensure safe separation of the UAV and manned aircraft.

The system concepts must be capable of being applied to all UAS assets, independent of UAV proprietary interfaces and size. Sense and Avoid is even more critical for small UAV which fly in clutter environments with other UAVs and manned aircraft. System must leverage Automatic Dependent Surveillance Broadcast (ADS-B) which is planned to be implemented by the Federal Aviation Administration (FAA) in the NAS. The proposed system should also address noncompliant ADS-B aircraft. This can be done with on board sensors. System should be less than 2 pounds using minimal space for small and expendable UAVs such as the Navy's SonoChute Launched UAVs. System should cost less than $3,000 to be affordable for small UAVs.

PHASE I: Develop an initial design approach and demonstrate the technical feasibility of the proposed technology.

PHASE II: Develop, construct, and demonstrate the operation of a prototype system on a small UAV.

PHASE III: Transition the developed technology for fleet and commercial use including airworthiness organizations, Range Safety organizations, and NAS sectors. Provide a detailed supportability plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by homeland defense as means of protecting against UAS threats. It could be used for UAV commercial ventures such as forest management or agriculture.

REFERENCES:
1. FAA Aircraft and Operator Requirements, Solution Set Smart Sheet, August 12, 2008. http://www.faa.gov/about/office_org/headquarters_offices/ato/publications/nextgenplan/0608/solution_sets/avionics/index.cfm?print=go.

2. Federal Aviation Administration Memorandum AFS-400 UAS Policy 05-01, "Unmanned Aircraft Systems Operations in the U.S. National Airspace System – Interim Operational Approval Guidance", September 16, 2005.

KEYWORDS: Unmanned Aerial Vehicles; National Air Space; Air Space Integration; Airworthiness; Range Safety; Sense and Avoid

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-033 TITLE: Highly Integrated, Highly Efficient Fuel Reformer/Fuel Cell System

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-263, Navy Unmanned Aerial Vehicles Program

OBJECTIVE: Develop innovative technologies for fuel cell system components and methods for integration to enable a highly compact and efficient fuel cell system that can meet stringent naval aviation electrical, operational, and environmental requirements. Proposed solutions which can minimize the logistic footprint of the packaged system while increasing efficiency and power density are sought.

DESCRIPTION: Fuel cells are seen as an enabling technology for both legacy and future aircraft platforms. The successful development and integration of fuel cell systems onboard aircraft could yield benefits such as increased fuel efficiency, reduced emissions, and reduced maintenance. The Navy seeks the development of enabling technologies for desulphurization and reformation of JP-5 jet fuel into the pure hydrogen fuel required for fuel cell power generation. These critical technologies are in the early development phases and require significant innovation and research in order to meet naval aviation requirements and application needs. In addition, multiple fuel cell types are being investigated for naval aviation applications including, but not limited to, Proton Exchange Membrane (PEM) and Solid Oxide Fuel Cell (SOFC), but significant research and adaptation of these technologies is required in order to meet naval aviation requirements.

Advanced technologies and methodologies are sought for the design, development, and integration of military-grade fuel cell system components (e.g. desulphurizer, reformer, fuel cell stack, and balance of plant) to enable a highly compact and efficient fuel cell system that can meet the stringent electrical, operational, and environmental requirements of naval aviation applications. Under this program effort, the critical technology areas to be addressed are high system efficiency, high power density, and air platform system integration.

Due to severe size and weight restrictions, fuel cell systems for naval aviation applications must be very compact. Systems capable of utilizing logistic JP-5 jet fuel to produce a pure hydrogen stream output equivalent to 10 KW electrical power, at a minimum, are desired. Actual requirements for the capacity of the fuel cell system may vary depending on the transitioning aircraft platform and/or application. The proposed technical approach must account for maximizing the life of the overall fuel cell system while meeting all other applicable naval aviation requirements.

Operational requirements include cold temperature start (-55C), short start-up time (1-8 minutes), short duty cycle (as severe as 1-2 hours on and 22-23 hours off per day, operating daily), air supply/intake (not available in purified form), and water management (no storage, water must either be recycled or removed). Electrical requirements include MIL-STD-704 power quality, high load inrush currents, rapid response to load changes, transients, and faults. Environmental requirements include temperature (-55C to 91C), altitude (up to 70,000 ft), shock (20G/11ms operational, 40G/11ms crash), vibration (17G functional, 28G endurance), and Electromagnetic Interference (EMI) (MIL-STD-461). In addition to meeting these requirements, the fuel cell system must prove to be cost-effective including meeting applicable acquisition, maintenance, reliability, and other operations and support goals. Applicable naval aviation requirements will be further defined throughout the development process.

PHASE I: Define a technical approach and an implementation plan for the design, development, and integration of an aviation based fuel reformer/fuel cell system. Validate the approach analytically or provide test data or bench top hardware that would validate the approach.

PHASE II: Design, develop, and demonstrate a highly integrated, highly efficient, prototype fuel reformer/fuel cell system that meets the requirements detailed in the description. Demonstration may include a high-fidelity laboratory environment and/or aircraft ground demonstration.

PHASE III: Optimize the highly integrated, highly efficient, prototype fuel reformer/fuel cell system to be utilized in a Navy aircraft application. Potential applications include auxiliary power unit (APU), battery replacement/supplement, secondary power source, small primary propulsion systems, and ground power carts.

Perform a functional evaluation of the optimized system displaying the improved performance of the overall fuel cell system. Demonstration may include an aircraft ground or flight demonstration.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The successful implementation of a highly integrated, highly efficient fuel reformer/fuel cell unit can be widespread and range across various military and commercial applications. The commercial aviation industry can utilize the technologies and/or processes to further increase power densities and reduce the weight of similar alternative power sources. Benefits could also carry into the commercial fuel cell sector with a primary impact on increasing efficiency while reducing size, weight, and volume of current technologies. Commercial fuel cell markets that could benefit from this technology include aviation, automotive, stationary power, and mobile electric power sources.

REFERENCES:
1. “Supporting next-gen propulsion”; Aerospace Engineering magazine, April 2007.

2. “Reformation of Jet Fuels for Navy Ground Cart Applications”, SAE Power Systems Conference 2006, Document Number: 2006-01-3095, www.sae.org/events/psc

3. “Boeing prepares fuel cell demonstrator airplane for ground and flight testing”, Fuel Cell Today, 28 March 2007, http://fuelcelltoday.com/FuelCellToday/IndustryInformation/IndustryInformationExternal/NewsDisplayArticle/0,1602,8971,00.html

KEYWORDS: Fuel Cell; Fuel Reformer; Fuel Efficiency; Integration; Thermal Management; JP-5 Jet Fuel

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-034 TITLE: <u>Affordable Broadband Radome</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-208, Aerial Target Systems; PMA-290

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OBJECTIVE: Develop innovative technologies resulting in affordable materials and manufacturing processes for broadband supersonic radomes.

DESCRIPTION: Current radomes qualified for supersonic flight are costly. Some are out of production and based on older generation manufacturing technology. Target systems often have the capability to carry varying radio frequency (RF) emitter payloads that transmit through the (typically composite) radome and the have the ability to integrate internal passive RF reflectors (Luneburg lens, concave or convex reflectors) inside radomes to augment signature. Innovative material and design solutions are needed to achieve low insertion and transmission losses for improved radome performance. Future weapon system radomes must effectively support seeker transmission but may in some cases need to limit reception of out-of-band RF interference and the definition of “broadband” may be considered more band specific. Material and design improvements should support supersonic capabilities at all altitudes. A separate design for the very high altitude supersonic/hypersonic mission capability is possible if it results in design, manufacturing or RF performance advantages. Designs should minimize receive and transmit losses from radome nose tip blockage (shadow area) for high Mach flight. An exception is a design option for the high altitude case for integration of a pitot probe through the radome nose tip with the necessary mounting interface.

Affordable manufacturing processes and material systems, that are environmentally stable in long term storage, are sought.

PHASE I: Develop concepts for radome designs, and manufacturing methods. Prove technical feasibility of the concepts and methods.

PHASE II: Develop and demonstrate full scale "operational" radome prototypes. Finalize and validate radome capabilities.

PHASE III: Finalize development with military, NASA, and commercial applications. Transition technology with resulting customers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Material and process advances from the project will feed corresponding improvements in the commercial sector for more durable affordable general purpose antenna radome covers with greater environmental stability. While the commercial sector will have fewer supersonic applications there is potential for dual use in the commercial space launch industry and potential to serve as enabling technologies in support of emerging supersonic transport aircraft.

REFERENCES:
1. Harris, Daniel, "Materials for Infrared Windows and Domes: Properties and Performance," SPIE Optical Engineering Press, 1999.

2. Chatsworth, CA, Sefton, H. B., Jr., "Four Band Radar Augmentation System for High Performance Targets," TECOM Industries Inc., Jan 1985, National Technical Information Service, NTIS Order Number:: ADP004625; http://www.ntis.gov/search/product.aspx?ABBR=ADP004625

3. Chang, D. C. "Comparison of Computed and Measured Transmission Data for the AGM-88 HARM Radome – Master's Thesis," Naval Post Graduate School, Monterey, CA., Dec 1993, National Technical Information Service, NTIS Order Number: AD-A274 868/9; http://www.ntis.gov/search/product.aspx?ABBR=ADA274868

4. Joy, E. B., Huddleston, G. K., Bassett H. L., Gorton C. W., Bomar S. H. "Analysis and Evaluation of Radome Materials and Configurations for Advanced RF Seekers – Final Research Report", Georgia Institute of Technology, Atlanta GA, , Jan 1974, National Technical Information Service, NTIS Order Number: AD-774 310/7; http://www.ntis.gov/search/product.aspx?ABBR=AD774310

KEYWORDS: radome; broadband; materials; supersonic; composite; ceramic

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-035 TITLE: <u>Digital RF Memory (DRFM) Jammer Simulator</u>

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: PMA-265, Super Hornet, Hornet; Air 5.4.4.2; Next Generation Jammer

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OBJECTIVE: Develop an open architecture generic threat Digital Radio Frequency Memory (DRFM) jammer simulation and stimulation capability that provides real-time threat emulation (with realistic threat waveforms) and accepts inputs from an intelligence database front end of specified parameters and generic mode description templates.

DESCRIPTION: The ability to rapidly prototype and analyze signal waveforms for emerging and constantly changing threat systems is needed in the intelligence and test and evaluation (T&E) communities. The problem is compounded due to the nature (classification) of the data associated with emulation of the waveform. The threat DRFM jammer emulation must be able to separate the unclassified hardware/software front end (while maintaining programmability and reconfigurability) from the actual classified threat data and modes it is required to emulate (in order to remove all classification issues). In order to achieve this goal, an innovative jammer emulation approach must be developed to insure that it is reconfigurable over a large set of parameters (i.e., frequency, bandwidth, number of analog-to-digital/digital analog converter (ADC/DAC) bits, clock rate, memory depth, etc) to sufficiently model the threat jammer hardware. It must also be easily and rapidly programmable to implement a variety of coherent and non-coherent electronic countermeasure (ECM) modes including (but not limited) to coherent false targets, coordinated range gate pull-off/vertical gate pull-off (RGPO/VGPO), uncoordinated RGPO/VGPO, and noise, etc. When a different number of ADC/DAC bits are being emulated, the RF response must match the threat data that is captured in the threat database. This type of stimulator does not yet exist. The jammer simulator should also have an interface to allow for external data inputs for controlling the simulator.

PHASE I: Determine the feasibility of and develop a conceptual design for an appropriate DRFM jammer emulator.

PHASE II: Develop detailed designs for the Phase I DRFM jammer emulator and fabricate a prototype suitable for proof of concept testing in a laboratory environment. Conduct preliminary testing demonstrating the DRFM jammer capabilities and performance.

PHASE III: Integrate Phase II prototype unit with a real-time executive using the Joint Integrated Mission Model (JIMM) thus allowing use with the existing RF stimulator resident at the test facility. Develop and fabricate a full-scale DRFM jammer emulator. This jammer will provide full-scale demonstration of all capabilities and will lead to a full-scale prototype demonstration unit.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed under this effort would benefit the commercial aviation community as well as the Department of Homeland Security (DHS). Potential applications for the RF generation of complex waveforms could be utilized to characterize radio frequency systems.

REFERENCES:
1. Introduction to Electronic Defense Systems, Second Edition, Filippo Neri, SciTech Publishing, 2006

2. Digital Techniques for Wideband Receivers, James Tsui, Artech House, 1995.

3. Electronic Warfare in the Information Age, D. Curtis Schleher, Artech House, 1999.

KEYWORDS: Electronic Attack; Electronic Warfare; Radar; Digital Radio Frequency Memory (DRFM); Jammer; Test and Evaluation (T&E)

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-036 TITLE: Impact/Erosion Resistant Environmental Barrier Coatings (EBCs) for Ceramic Matrix Composites (CMCs)

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter, Propulsion

OBJECTIVE: Develop and demonstrate innovative, impact/erosion resistant EBCs for Silicon Carbon (SiC) fiber-based CMCs.

DESCRIPTION: The JSF and other military platforms are targeting the use of CMCs for propulsion applications with a goal of increases in specific power. Concerns still exist regarding the degradation of CMCs at elevated temperature due to life limiting phenomena associated with thermal, chemical, and environmental instability of those material systems. EBCs or some other specifically purposed coatings in CMCs have been used at temperatures below 2,400 degrees Fahrenheit (1,316 degrees Celcius) in order to mitigate such deleterious environmental effects encountered in harsh engine operating conditions [1,2]. EBCs, however, have been shown to be highly susceptible to foreign object damage (FOD) [3] when subjected to particle impact or erosion by foreign objects ingested into hot sections of engines, as often observed in thermal barrier coatings (TBC) [4]. Impact/erosion, that exceeds certain limits, would result in spallation/delamination of EBCs, thus leading to premature failure of related CMC components. Furthermore, re-coating of EBCs is not economically feasible in many cases involving procedures that would be significantly cost-ineffective. It is, therefore, from a perspective of cost and performance, highly desirable to develop pertinent, prime-reliant EBCs that could withstand or alleviate impact/erosion damage at elevated temperatures to enhance overall durability and reliability of CMC components. The approaches should not degrade the important properties of EBCs such as thermal, chemical, and water-vapor stability with temperature capability below 2,400 degress Fahrenheit. Particular emphasis is in SiC fiber-based CMCs.

PHASE I: Develop innovative approaches to enhance impact/erosion resistance of EBCs in SiC fiber-based CMCs. Demonstrate the technical feasibility by fabricating and testing preliminary material systems.

PHASE II: Develop, demonstrate, and validate the pertinent EBC systems developed in Phase I. Evaluate the EBCs in terms of impact/erosion durability through appropriate tests using a reasonable number of test coupons.

PHASE III: Transition the approach to the Joint Strike Fighter (JSF) and other propulsion applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: CMC propulsion components have a great potential to transition to civilian aero engine applications. The resulting material development, albeit risky, could allow a significant life-cycle cost saving while the developed material could outperform the conventional coating systems.

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2. Bhatia, T., Eaton, H., Sun, E., Lawton, T., Vedula, V.; “Advanced Environmental Coatings for SiC/SiC Composites”, ASME Paper No. GT2005-68241 (2005), ASME Turbo Expo 2005

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KEYWORDS: Environmental Barrier Coatings (EBC); Ceramic Matrix Composites (CMC); Impact; Erosion; Foreign Object Damage (FOD); Silicon Carbon (SiC) Fiber-Reinforced CMCs

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-037 TITLE: Investigation of the Debye Effect for Submarine Detection

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-264, Air ASW Systems, Advanced Sensor Application Program - ACAT IV

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OBJECTIVE: Investigate and evaluate the electric and magnetic fields caused by the Debye effect as a method of submarine detection.

DESCRIPTION: The U.S. Navy makes extensive use of electric and magnetic field phenomena in the detection of submarines. Key magnetic phenomena are generated from the Ferromagnetic, Static Horizontal Electric Dipole (HED) and Alternating HED moments.

The Debye effect is an acousto-electrokinetic phenomena which has not been extensively investigated to determine its potential for the detection of submarines. The Debye effect causes the generation of electric and magnetic fields due to fluid particle acceleration in an electrolytic solution (in this case the ocean). The effect results from the separation of charges due to differences in the masses and mobilities of the ions; in a moving solution the ions are drawn along differently by the moving fluid and are displaced relative to each other. The effort in this task is to determine the magnitude of the electric and magnetic fields caused by acoustic signals as a function of distance from the source in the ocean. At least two methods of detection may be investigated; in-air detection via aircraft monitoring which is similar in concept to present day Magnetic Anomaly Detection (MAD); and by an insitu sensor which contains an appropriate magnetic or electric sensor. Predictions performed should be for both air and water as a function of various environmental conditions and all sources of potential interfering noise against which the signal must be detected, determined and analyzed. The type of acoustic signals investigated may include narrowband signals, broadband signals, explosive type signals (transients) and quasi periodic explosive wave trains. Parameterize the levels of the acoustic signals to determine the minimum level signal needed to achieve detection. Appropriate signal processing techniques should be addressed.

PHASE I: Determine the feasibility of the Debye effect as a method of submarine detection. Develop analytical solutions for the magnitudes of the electric and magnetic fields. Extend the theory of the Debye effect if possible to hydrodynamic signals (e.g. vortices). Provide numerical estimates of the feasibility of using the Debye effect for submarine detection.

PHASE II: Finalize and extend critical concepts developed in Phase I. Determine the “optimum” frequency for detection. Perform simulation of the detection method and validate via tank testing. Fabricate, verify and evaluate a prototype over-the-side sensor system for ocean use.

PHASE III: Finalize and validate design. Transition developed technology to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Methods and sensors investigated under this task could be used by oceanographers to measure the natural occurring electric and magnetic fields in the ocean.

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2. Peddell, J. B.; Leach, P. D., "Mechanism for Acousto-Electrokinetic Coupling", IEE Colloquium on Common Modeling Techniques for Electromagnetic Waves and Acoustic Wave Propagation", Vol. Issues, 8 Mar 1996, Pages 1011-1016

KEYWORDS: Debye effect; electric field; magnetic field; acoustic; hydrodynamic; transient

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-038 TITLE: Innovative Concepts for Composite Leading Edge Self-Monitoring Anti/De-icing System

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

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

OBJECTIVE: Develop and demonstrate an innovative self-monitoring anti/de-icing system for composite leading edges.

DESCRIPTION: Aircraft aerodynamic surfaces today have a major issue with ice build-up. Ice build-up on wings causes an uneven flow of air over the wing surface resulting in an increase of drag and/or decrease of lift. With recent progress in technology, more new aircraft are using composite materials for major structural parts, such as wings or rotor blades, to save weight while improving fatigue strength. Issues arise when current de-icing solutions are applied to these composite surfaces. Composites and metals behave differently when exposed to extreme temperatures. Current thermal anti/de-icing systems work by raising temperature to melt and remove ice buildup. Overheating caused by these anti/de-icing agents can cause damage, such as delamination and micro-cracking, in the composite materials.

An innovative, self-monitoring, anti/de-icing system for composite aerodynamic surfaces, e.g. wings and rotor blades, would reduce the issues currently experienced. This system must monitor the conditions of the surface in order to detect potentially dangerous icing situations and activate the system, if necessary. To assist with repair and maintenance, the system should be self-monitoring to ensure it is properly functioning and to detect any faults or failures. The system should continuously self-monitor the health and condition of the composite structure; for example, detect foreign object damage (FOD), such as that from hail or bird strike, or excessive erosion. The system should be light in weight and utilize minimal power compared to anti/de-icing system currently being used, and contain an override to enable activation/deactivation on command.

Simulate different malfunctions and show how the system reacts. Both experimental evaluation and verification via proven computational methodologies must be demonstrated.

PHASE I: Develop an innovative concept for a self-monitoring anti/de-icing system to protect composite leading edges against icing. Demonstrate feasibility of the anti/de-icing concept.

PHASE II: Develop and demonstrate a prototype anti/de-icing system in a simulated representative icing environment. Validate and demonstrate the self-monitoring capabilities.

PHASE III: Transition the anti/de-icing system for implementation by Original Equipment Manufacturer's (OEM) or onto an existing platform. Prepare a complete package with a users manual, hardware and software for the system to be integrated onto Navy platforms. Provide the Navy with computational tools capable of assessing the system across a spectrum of Navy aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: With the increased use of composite materials for aircraft structures in both the military and commercial aerospace industries, this technology will have a broad application in the aerospace community where icing issues exist.

REFERENCES:
1. Botura, Galdemir and Alan Fahrner, “Icing Detection System – Conception, Development, Testing and Applicability to UAVs,” Goodrich Corporation (AIAA 2003-6637)

2. Elangovan, R. and R. F. Olsen, “Analysis of Layered Composite Skin Electro-Thermal Anti-Icing System,” The Boeing Company (AIAA-2008-0446)

KEYWORDS: Composites; Anti/De-icing; Leading Edge; Self-Monitoring; Low Weight; Foreign Object Damage

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-039 TITLE: Innovative Quiet Unmanned Air Vehicle Technologies

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: PMA-263, Navy Unmanned Aerial Vehicles Program

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OBJECTIVE: Develop novel approaches and applications to reduce the acoustic emissions of current Unmanned Aerial Vehicles (UAV) without significantly impacting vehicle performance (speed, endurance, payload, etc.).

DESCRIPTION: Due to the surveillance nature of many UAV missions, the intent of this work is to reduce the acoustic detection probability for a given system. This includes evaluating different technologies to reduce acoustic emissions of propulsion systems (i.e. exhaust/muffler and propeller designs), and technologies to facilitate acoustically improved vehicle integration. Since each UAV system has unique noise issues, this effort seeks to identify technologies and approaches that show improved acoustic performance with an understanding of the impact to the rest of the UAV performance parameters. Novel hardware approaches should have size, power and weight considerations that are appropriate to small UAV systems.

The basic problem to overcome is the physical limitation of integration while providing effective noise reduction to an observer, and potential performance impacts of adding noise reduction devices to a relatively small airframe. Any proposed approach should provide improved noise emissions to observers on the ground and address the potential impact to vehicle performance.

A longer term objective will be to demonstrate the maximum capability of combined technologies on a prototype UAV of comparable size and performance of a Shadow UAV.

PHASE I: Demonstrate the technical feasibility of reducing acoustic emissions on UAVs without significant impact to UAV performance. Develop a detailed analysis of predicted performance of the proposed technology.

PHASE II: Develop, demonstrate, and validate the proposed technology integrated on a UAV

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Noise reduction technologies have applications in almost any mechanical environment. Specifically, commercial UAV and even Remote

Controlled (RC) Hobby vehicles are limited in uses due to noise emissions. Additionally, technologies developed under this work could be applicable to other devices with similar noise sources such as automobiles, fans/propellers, industrial facilities, and other mechanical systems. The added restrictions for application to UAVs make the technologies more attractive to other applications in that they may be lower weight, smaller, have lower performance impact.

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3. Fidler, Kenneth, "Subsystem Acoustic Testing of a VTOL Ducted Propeller UAV", March 2004, AMRDEC Technical Report AMR-SS-04-05.

4. Lo, K., Ferguson, B., "Tactical Unmanned Aerial Vehicle Localization Using Ground-Based Acoustic Sensors", 2004.

KEYWORDS: UAV; noise reduction; acoustics; aeroacoustic; low noise; quiet UAV

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-040 TITLE: <u>Acoustic Stability Prediction In Solid Rocket Motors</u>

TECHNOLOGY AREAS: Air Platform, Battlespace, Weapons

ACQUISITION PROGRAM: PMA-259, Air-to-Air Missile Systems

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OBJECTIVE: Develop a ballistic model coupled to a three-dimensional acoustic mode solver that improves solid rocket performance prediction ballistic and acoustic stability calculations.

DESCRIPTION: The Navy, Air Force, Army, and to some extent NASA, currently depend upon Air Force funded Solid propellant rocket motor Performance computer Program (SPP) to evaluate the acoustic stability of solid rocket motors. Recently, numerous development rocket motors have experienced stability concerns that are outside the predictive capability of the current stability codes. These include rate-mechanical relationships on stability and flow around stress relief slots that are found on nearly all tactical motors. It is proposed to increase the stability predictive capability of our current models to include these recently observed phenomena. The rate-mechanical anomalous behavior is believed to result in changes in local burning rate brought on by grain geometry stress and strain that result from motor pressurization, grain deformation, and uneven loads on the motor solid propellant grain. Vortical flow improvements will allow more accurate ballistic predictions resulting in better acoustical flow interactions around and from slots and fins in the motor grain. These interactions are believed to have caused or contributed to several recent motor problems. The current codes relay on outdated matrix solvers to predict the acoustic coupling with the ballistic fluid dynamics. Newer methods are available to improve both the accuracy and improved resolution of the internal fluid dynamics. Finally, with minor changes to the current ballistics code, prediction of the level of thrust oscillation for a given pressure oscillation would be a helpful feature to add to the current code. This feature would be useful to system engineers wanting to know at what level oscillatory combustion would affect the seeker and control sections.

PHASE I: Determine the feasibility of developing a ballistic model that couples to a three-dimensional acoustic mode solver. The models must be adaptable to the existing framework of current stability prediction models.

PHASE II: Develop and demonstrate prototype physical models and implement into the framework of an existing three-dimensional grain design and ballistics code. This will include stress and strain mechanical property models, vortical flow models, and improved numerical solvers.

PHASE III: Refine the code including operational manuals, test cases, and graphical interfaces and provide a variety of versions for transition into relevant computer platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improved methods for evaluating the acoustic stability of solid rocket motors will be directly applicable to organizations providing commercial launch services to the satellite industry. Launch vehicles that are considered rely on solid rocket motors as a means of propulsion. Technology developed under this SBIR effort would provide improvements in the accuracy to predict solid rocket stability, yielding cost reductions in solid rocket motor development.

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2. "Some Influences Of Nonlinear Energy Transfer Between The Mean Flow And Fluctuations," F.E.C. Culick, G.C. Isella, California Institute of Technology, Proceedings of the JANNAF Combustion Meeting, CPIA-PUB-662-Vol-II, Oct 97.

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8. "Pulsed Motor Firings," F.S. Blomshield, NAWCWD, China Lake, NAWCWD TP 8444, March 2000.

KEYWORDS: Combustion; Solid Rockets; Stability; Grain Design; Ballistics; Performance Prediction

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-041 TITLE: High Temperature Survivability Coating Materials with Innovative Application Processes

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA-201, Precision Strike Weapons; PMA-266; Joint Strike Fighter

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OBJECTIVE: Develop high temperature survivability coating concepts with corresponding vulcanization and co-cure bonding application processes for airframe component integration. The coating concepts should be loadable with fillers with properties for either electromagnetic interference/radio frequency (EMI/RF) control or thermal insulation.

DESCRIPTION: Many high temperature elastomers operate at temperatures of 350 to 500 degrees Farenheit. There is a need for innovation and expansion of material options and processes to address challenging high temperature coating applications from 600 through 1300 degrees Farenheit. EMI/RF coatings tend to be thick and, for spray applications, require repetitive and lengthy build-up processes at several mils per coating pass. Elastomeric sheet materials can be formed to necessary thicknesses with compression forming or calendaring but the sheet material must still be applied to components with adhesives. Innovative methods are sought to apply the coating(s) to components by vulcanization for metal substrates or by co-cure for composite structures without thick adhesive layers. It is desired that coating materials pursued not contain methylenedianiline (MDA) polyimide and should minimize the use of other highly volatile compounds where possible. The coating materials should be able to withstand both subsonic and supersonic airflow conditions when used externally on airframe components. A sprayable variant of the molding material or other alternative is also desired but not required.

Future system airframe substrates and components will continue to be made from aluminum and steel, complex composite structures, and plastics. Vehicle areas exposed to high temperatures may include engine exhausts, motor combustion sections, inlet ducts and faces, wings and fins, nose tips, and other protruding surfaces such as fairings and pitot probes. Developing reliable, vulcanization processes for formation bonding elastomeric sheet material to airframe components with minimal priming and without the additional steps of adhesive layers would yield a cost and labor benefit for sheet materials over spray coating applications. Vulcanization and composite pre-preg processes employ elevated temperatures and are a good match for research into high temperature elastomers and fillers. The high temperature materials developed would likely also serve well as very durable coatings for applications encountering only low and moderate temperatures.

Material candidates should at a minimum withstand in-service sustained operation at 500 degrees F for 1 hour and long term use at lower 450 degrees F temperatures. Long term operation at 650 degrees F is desired. Reliable one-time use temperature operation at 680 degrees F for 10 minutes without degradation is required as a primary project objective, while the goal would be capability for one-time operation at 800 degrees F for 10 minutes without any significant degradation. A solution is also sought for one time operation at temperatures approaching close to 1300 degrees F for 10 minutes. If necessary this 1300 degrees F need can be addressed by a different material though a common material would be ideal. In addition to protection from these temperature exposures, the coating should survive in supersonic airflow at low or high altitude. If materials considered have ablative properties, temperature of intumescence should be at least above 700 degrees F and ideally above 1300 degrees F. It is a goal that manufacturing cure processes to apply the coatings do not require elevated temperatures above 400 degrees F.

The goal of this effort is to demonstrate sheet material EMI/RF shielding performance prior to vulcanization or co-cure. Investigate potential methods for verification of installed EMI/RF performance or quality assurance after part assembly. Demonstrate adhesion performance of samples with respect to MIL-SPEC standards including tensile and shear strength performance at room temperature and elevated temperatures to the extent possible. Research any potential issues with molding contaminants and develop processes to minimize or remove them. Investigate methods to minimize and assess bonding issues such as void content. Materials should be resilient against micro-cracking issues while in service. Demonstrate final material performance to MIL-STD 810 environmental standards.

PHASE I: Demonstrate the technical feasibility of developing the coating material and corresponding application process technologies. In Phase I, develop detailed Phase II research and prototype plans that include definition of success criteria, manufacturing demonstration, and test verification. Plans should include test verification of material durability, stability, EMI/RF control performance for samples and installed performance for prototypes with testing at elevated temperatures.

PHASE II: Develop, prototype, optimize, and validate a high temperature elastomer material with a filler formulation for electromagnetic shielding/RF control and a secondary formulation for thermal insulation. If possible demonstrate proof-of-concept durability of the coatings in subsonic airflow and high temperature supersonic airflow. Prototype a vulcanization process for applying the loaded elastomer to notional parts to include a steel and aluminum control fin and an aluminum wing without the use of adhesive layers. Prototype a co-cure process for coating application within a multi-layer composite structure such as an inlet duct. Investigate co-cure onto an external plastic structure such as a nylon inlet and inlet face edges. Document the research, theory, and materials and manufacturing process steps and technologies developed. Develop cost information and manufacturing specifications for producing and processing the loaded elastomer materials.

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

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector commercial dual use applications include airframe and component thermal insulation, rain and sand erosion boots for leading edges, and high temperature EMI gaskets and seals. Air platforms supported could be supersonic transport aircraft, space launch systems, civil aviation aircraft, helicopters, and UAVs. Ground and sea systems may also benefit. Rubber, coating, and composites manufacturing industries will benefit.

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KEYWORDS: high temperature; elastomer; coating; vulcanization; co-cure; shielding

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-042 TITLE: Environmental Wideband Acoustic Receiver and Source (EWARS)

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA-264, Air Anti Submarine Warfare Program; PMA-290

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OBJECTIVE: Develop and demonstrate an innovative air-deployable source and receiver combination that is capable of characterizing the acoustic ocean environment over a wide range of frequencies from Navy Maritime Patrol and Reconnaissance Aircraft with the capability of crossing multiple operational environments.

DESCRIPTION: Currently, no calibrated coherent source/receiver combination for environmental characterization exist due to bandwidth and responsiveness limitations of existing transmitter/receiver elements. Innovative sensor technologies are sought with enhanced electromechanical property ceramics with increased bandwidth and responsiveness for the transmitter and receiver elements that are capable of transmitting, collecting, and processing surveillance information. There is a need within the Navy, and other DoD agencies, to characterize the ocean environment for pre-mission planning, environmental analysis, and marine mammal mitigation during training and operational trials. Larger intelligence data demands, reduced inventory, aircraft capacity, and fewer manned aircraft make it difficult to meet all intelligence/ mission planning requirements with existing hardware. Additionally, scenario characteristics such as transmission loss, bottom loss, reverberation, geo-acoustic characterization, obscuration, clutter, multi-path, signal detection, and signal type may limit the performance of current intelligence gathering systems without the capability to gather and disseminate the information. System solutions should include both single unit concepts as well as multi-unit concepts.

The unit should be capable of both shallow and deep water operations deploying the active and passive sensing elements through 500 feet, and have a minimum one-hour life (or 50 pulse seconds). Coherent signals of interest are up to 100 kHz, to include but not be limited to CW and FM waveforms. Communication between the aircraft and sensor unit should be compliant with NATO digital uplink format to the Software Defined Sonobuoy Receiver (SDSR).

This expendable sensor solution should be low power and sized to fit within an “A” size sonobuoy. A-size sonobuoy standards are as follows: dimensions of 4.875-inch diameter x 36-inch length and weight of 40 pounds or less. It is desirable to accommodate the wide band of frequencies in a single transducer or set of transducers within a single unit, though it may be necessary to partition the frequency range into multiple units.

PHASE I: Develop the sensor concept, design details and conceptual packaging details, and demonstrate feasibility.

PHASE II: Develop and fabricate an over-the-side prototype unit(s) required to span the frequency range and demonstrate in both acoustic facilities and the ocean environment. Finalize the concept design and make recommendations for Phase III production-oriented designs.

PHASE III: Develop a production design of Phase II solution. Conduct integrated engineering and operational testing of an air deployed system. Demonstrate full operational functionality in Navy-supported test scenarios. Transition to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology developed in this SBIR could be leveraged to achieve smaller and lighter systems. This type of system capability may be of interest to the undersea mapping, exploration, seismology and weather communities and used for monitoring marine mammals or icebergs. Government agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Department of Commerce are continually trying to upgrade their measurement and data collection capability. These sensors could fulfill a need to provide in-situ measurements at frequencies not ordinarily measured. By developing reliable, low cost sensor components, more capability and performance can be achieved.

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KEYWORDS: Sonobuoy; Sensor; Hydrophone; Undersea; Active Acoustics; AntiSubmarine Warfare

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N101-043 TITLE: Low Cost, Reliable Towed Sensors Handling Systems

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

ACQUISITION PROGRAM: PEO Submarines, Towed Sensors Systems PMS401, ACAT I

OBJECTIVE: Develop innovative concepts for a low cost, reliable thin-line towed array (TLTA) handling system having a long service life.

DESCRIPTION: Current handling systems for deploying and retrieving the Navy’s thin-lined towed arrays from submarines subject the arrays to more stress than desirable for reliable performance and long array service life. This topic seeks non-traditional hydraulic innovative concepts for a towed array handling system that can deploy, stow, and retrieve a tow cable and array having a length of up to 5000 feet with a 1.5 inch diameter. The concepts must include novel approaches for handling system locations that that minimize mechanical forces on the array, do not affect the hydrodynamic flow of the submarine, support ease of operations and support pier side maintenance and inspection. The design must support handling of legacy TB-29A and TB-23 arrays as well as the Next Generation Thin Line Towed Array.

The handling system should include the mechanical components as required for design concepts (e.g capstan, roller boxes, guide trunk, stowage reel concepts) as well as all operational sensors, motors, and the mechanical interface between the handler and the array. Specifically, concepts are sought that minimize mechanical forces on towed array, and support ease of operations and maintenance. The system must also operate on the existing shipboard electrical supply. More specifically, systems should minimize forces transmitted to the internal wiring, connectors, sensitive electronics (including programmable components), and optical components. The design must not introduce additional noise, strum or electrical artifacts.

Submissions are required to propose realistic and innovative handler installation location(s) concepts that minimize mechanical stress on the towed array and minimizing stress on vertical and horizontal stabilizers of the tow platform. The proposed installation concept must consider peir side maintenance activities and support ease of preventive and corrective maintenance activities.

Design approaches must Reduce Total Operating Costs (RTOC) and improve handler reliability to meet or exceed 90% for 365 days while demonstrating (2) two full operational cycles (1 deployment and 1 retrieve) per day, while maintaining operational tactical capabilities of the towed array.

Proposals will be expected to measure forces, accelerations, stresses, and strains to key parts of a thin-line array during deployment and retrieval so that the Navy can accurately assess proposed designs in terms of potential damage to the towed array and its internal components. Offerors are not expected to develop dummy arrays.

Government Furnished Information (GFI) may be provided after award on existing dummy arrays and such arrays may be provided as Government Furnished Equipment (GFE) after Phase I. Such GFI and GFE will not be provided during the Solicitation period.

The main structure components (storage drum, capstan, guide and tubes) must incorporate low cost, high strength, light weight, corrosion resistant materials and have a 30 year service life in the submarine operating environment that includes the range of operational depths and sea water chemistry.
The handling system should also operate and survive during vibrations associated with towing conditions during SSN high speed maneuvers. The handling system should also survive stowage (non-operational) temperatures from -40 degrees C to 60 degrees C, and operating temperatures from -2 degrees C to 40 degrees C. It must also survive rapid changes in temperature associated with submergence in extremely cold and warm environments

PHASE I: Develop concepts and studies that provide realistic, innovative towed handler locations and handling system concepts that support an approach leading to the fabrication and installation of an innovative handling system that meets all mechanical and electrical requirements. Identify fabrication methods, proposed materials and approaches to demonstrate feasibility. Perform material tests and analytical modeling to support the design. Develop approaches to test proposed design that will yield measurements of acceleration forces, stresses, and strains that will permit an objective assessment of the potential damage to the towed array during launch and retrieval at variable speeds.

PHASE II: Develop and model a scale prototype based on the approved conceptual design and concepts of Phase I.. Demonstrate system performance through modeling or analytical methods over the required range of parameters including numerous cycles.

PHASE III: Develop and produce full scale prototype towed array handling equipment which satisfies the descriptions in Phase I and II above. Demonstrate performance with an instrumented dummy towed array. The Program Office will fund final development of a system meeting this requirement. The prototype will then be tested, 1500 cycles, at a designated facility to determine it's reliability, effectiveness and Operational Availability (Ao) when exposed to the stresses similar to submarine operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private/commercial sector may benefit from this technology in the commercial seismic exploration and arrays monitoring systems.

REFERENCES: (publicly available from various sources on Internet)
1. Mil-S-901D, Shock Test, High Impact, Shipboard Machinery.

2. MIL-STD-167-1A, "Mechanical Vibrations of Shipboard Equipment (Type I – Environmental and Type II – Internally Excited)".

KEYWORDS: Keywords: light weight, affordability, reliability, Composites, polymeric materials, towed arrays, deployment, recovery, handlers

N101-044 TITLE: <u>Embedded Acoustic Sensors on the Surface of Composite Sonar Domes and Aluminum Hull Sections</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT I AN/SQQ-89A(V) 15

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Provide a way to cost effectively embed acoustic sensors on the surface of composite sonar domes and on underwater aluminum hull structures.

DESCRIPTION: As the Navy moves toward composite material solutions for sonar system dome development and non-steel hull materials, there will be an increased need for embedding sensors on the surface of these structures. In particular, as the Navy develops new and improved aluminum hull structures and/or composite sonar domes, there is an opportunity to integrate low cost conformal sensor arrays on both these surfaces, thereby improving overall sonar system performance. There is also a need to be able to repair these systems in order to maintain overall USW performance.

PHASE I: Research various new materials for use with aluminum hull structures and composite sonar domes. Develop a low cost process for embedding large arrays of acoustic sensors onto these surfaces. Investigate various repair techniques. Prepare prototype test panels using aluminum as well as composite materials, with arrays of embedded acoustic sensors.

PHASE II: Develop the detailed manufacturing processes and procedures for embedding different types of sensors on the surface of a composite sonar dome as well as aluminum hull sections. Build full-scale aluminum and composite sonar dome test panels containing arrays of acoustic sensors, and conduct acoustic and mechanical tests on the panels. Analyze the test data and optimize the design and manufacturing processes with respect to application techniques, longevity, performance, maintenance and life cycle cost.

PHASE III: Develop and fabricate full-scale aluminum hull sections and composite sonar dome(s) with arrays of embedded acoustic sensors. Install the systems on a research vessel or Navy ship with a sonar system, and conduct at–sea testing to assess the benefits to the Navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to Navy uses, the materials and processes could be used to develop various types of commercial sonar systems to detect threats to tankers, cargo carriers, and passenger ferries.

REFERENCES:
1. Kinsler, Frey, Coppens and Sanders Fundamentals of Acoustics, John Wiley & Sons, New York, 1982.
Urick Principles of Underwater Sound, McGraw-Hill Book Company, New York, 1983.

2. Carlsson, Adams and Pipes Experimental Characterization of Advanced Composite Materials, CRC, New York, 1986.

3. Ashbee Fundamental Principles of Fiber Reinforced Composites, Technomic Publishing Company, Lancaster, PA, 1989.

KEYWORDS: Embedded acoustic sensors, composites, sonar domes, hydrophones

N101-045 TITLE: Advanced Marine Generator for Combatant Craft

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 325G, Small Boats and Craft

OBJECTIVE: Development of an advanced power generation system for combatant craft with breakthrough technology for electrical generators. The goal is to provide two to three times the power rating of conventional generators with weight-to-power ratios equal to or less than current technology. Technologies must be able to withstand severe marine operational duty cycles, endure harsh maritime environments with corrosion resistance, embody ruggedness to withstand repeated wave impacts, and demonstrate extended life performance. Novel approaches that lead to increases in power output will enable increases in mission system capability without sacrificing payload weight or personnel transport capability.

DESCRIPTION: Today's forces employ combatant patrol and assault craft that rely on speed, acceleration, and maneuverability for survivability and multi-mission success. These capabilities are at risk because of the increasing demand to carry extensive payloads (e.g. combat troops, C4ISR equipment, weapons, ballistic armor, etc.). As payload demand increases, the craft's speed, agility, and survivability decreases while acquisition costs increase. Increased capability and increased payloads must not come at the expense of sacrificing speed and acceleration. The environments in which these craft operate expose the vessels to sand, mud, oil, and seawater spray as well as potential ballistic hazards. Current power generation systems for craft are typically modifications of land systems designed for heavy trucks or stationary land-based power generation. On-road or stationary systems have different operational duty cycles than craft systems and weight-to-power ratios in the 45-60 lbs/Kw range. The differences in the engines for these on-road or stationary applications result in reduced reliability and shorter life spans in marine applications.

This topic seeks to identify and apply innovative solutions for future combatant craft generators that will be scalable or modularized. They must be able to meet power demands on the order of two to three times current capability with weight-to-power ratios less than or equal to 20-30 lbs/Kw. Achieving this goal could increase mission capability while reducing power system weight. Desired features include the ability to supply clean AC and DC power simultaneously, limited maintenance, limited or no support systems, noise and vibration controls, multi-module stacking for larger craft applications, and rapid removal for mission flexibility, repair, or expeditionary land-based applications.

The Science and Technology Strategic Plans for the Navy Expeditionary Combat Command and the Naval Special Warfare Command cited "advanced high capacity power generation" for watercraft as a future capability objective (ref 3). Successful innovation and technology transition of a light weight, maritime power generation system will provide a significant step toward achieving this objective.

PHASE I: Demonstrate the design feasibility of an innovative 30-40 Kw range combatant craft generator with weight-to-power ratios on the order of 20-30 lbs/Kw or less. Perform bench top experimentation where applicable to demonstrate concepts. Complete preliminary design that addresses the needs as identified above.

PHASE II: Develop, demonstrate and fabricate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Verify final prototype operation in a representative laboratory environment and provide results. Develop a cost benefit analysis and a Phase III installation, testing, and validation plan.

PHASE III: Working with government and industry, construct a full-scale prototype and install onboard a selected combatant craft. Conduct extended shipboard testing. The small business will pursue global commercial markets in applying the new technology to commercial craft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The vendor will be able to market the new capabilities to over twenty boat builders who serve the U.S. military and commercial markets, as well as the international small boat commercial industry.

REFERENCES:
1. American Boat and Yacht Council Standards and Technical Information Reports for Small Craft, Section E-11.

2. American Bureau of Shipping. "Guide for Building and Classing High Speed Craft." October 2001.

3. NECC Science and Technology Strategic Plan. October 2007.

KEYWORDS: advanced power systems; marine generator; weight-to-power ratio; small boats; combatant craft

N101-046 TITLE: Wideband Acoustic Communications Transducer

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS401 ACAT III

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OBJECTIVE: The proposed SBIR program will develop a single wide-band acoustic transducer product line to provide a mid-frequency digital acoustic communications (ACOMMS) capability, voice communications, and special warfare communications for the submarine fleet. This capability addresses the requirement for submarine communications at speed and depth while providing a single product line to offer a functional replacement for low and high frequency ACOMMs transducers. The reduction in numbers and types of units will lead to overall life-cycle cost savings.

DESCRIPTION: Unlike the rest of the submarine fleet, when configured with APB05 (Advance Processor Build), SSGN does not have a Medium Frequency active array for Digital ACOMMs. An off-board sensor communications capability is required for communications with tactical paging buoy concepts in support of submarine communications at speed and depth initiatives. In addition, emerging requirement exists to support special warfare vehicle communications. For life-cycle cost savings, a need exists to consolidate existing add-on transducers into a single embedded capability.

This SBIR program will be structured to develop a transducer to replace the TR-232 and the TR-233 transducers on the SSGN. The transducer will also provide functionality currently found in the ITC-1007 and the 3WPCAT transducers. This transducer will also be engineered to provide directional transmit and receive capability.

To successfully produce a transducer with the required bandwidth and source level capability while adhering to the TR-233 physical design constraints, it is anticipated that advanced transduction materials will be required. Single crystal materials, under development at the Office of Naval Research, have shown to have the required performance capabilities. The proposed SBIR project will facilitate transition of single crystal transduction materials technology to fleet use while directly addressing an outstanding fleet requirement.

In 1997, it was discovered that single crystals of certain relaxor ferroelectric (lead magnesium niobate – lead titanate, and lead zinc niobate – lead titanate) materials exhibit extraordinary piezoelectric properties, namely, electromechanical coupling exceeding 90% (compared to 70-75 %, in state-of-the-art piezoceramics) (Refs. 1 and 2). Additionally, there is a 10 dB or more improvement in the material figure-of-merit for strain energy density, as well as a reduction in stiffness of 70%, relative to PZT-8 ceramics. These three material properties allow for projectors with increased source level and/or decreased size with dramatically enhanced bandwidths. Concerted efforts to grow these materials in a variety of forms, compositions and orientations now yield materials in quantities, and at a price, suitable for sensor applications. Three domestic manufacturing firms now supply these materials as well as several more overseas; initial devices have been developed and commercialized (References 3-6).

Development of the SSGN wide-band acoustic communications transducer will include design, fabrication, performance testing, environmental qualification testing, and delivery of a wide-band acoustic communications transducer for installation as a “form-and-fit” replacement for the TR-233 transducer.

PHASE I: A transducer design will be completed that meets the requirements for mid-frequency digital ACOMMs while also meeting all specifications for the TR-232 and TR-233 transducers. The design will be fully compatible with existing TR-233 mounting, cabling, and ship-board electrics and software. A cost analysis will also be conducted, including accurate production cost estimates, to quantify the potential cost saving benefits of the transducer consolidation approach.

PHASE II: Prototype transducers will be fabricated and laboratory tested according to Navy standard performance and environmental qualifications; including receive and transmit response, mechanical reliability, shock, and operating temperature and pressure. Design modifications and sensor rework will be included as necessary to meet specified requirements. Ship interface and integration plans will also be developed.

PHASE III: Production representative units (PRUs) will be fabricated and tested for final performance and environmental qualification. The PRUs will be subjected to all qualification testing required of TR-232 and TR-233 acoustic communication transducers. Qualified units will be delivered to PMS-401 for installation on available platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Productization of a wide-band ACOMMs transducer has significant commercial potential. As a product for supply to the U.S. Navy, there is potential for application on all Navy ships and submarines with regular replacements. There is also potential for application to the undersea resource exploration industry as a communications means for unmanned undersea vehicles.

REFERENCES:

1. S.E. Park and T.R. Shrout, “Ultrahigh Strain and Piezoelectric Behavior in Relaxor based Ferroelectric Single Crystals, “J. Appl. Phys., 82[4], 1804-1881 (1997).

2. S.E. Park and T.R. Shrout, “Characteristics of Relaxor-Based Piezoelectric Single Crystals for Ultrasonic Transducers,” IEEE Trans. On Ultrasonic Ferroelectrics and Frequency Control, Vol. 44, No. 5, 1140-1147 (1997).

3. J. M. Powers, M. B. Moffett, and F. Nussbaum, "Single Crystal Naval Transducer Development," Proceedings of the IEEE International Symposium on the Applications of Ferroelectrics, 351-354 (2000).

4. Jie Chen and Rajesh Panda, "Review: Commercialization of Piezoelectric Single Crystals for Medical Imaging Applications," Proceedings of the 2005 IEEE Ultrasonics Symposium, 235-240 (2005).

5. Mark B. Moffett, Harold C. Robinson, James M. Powers and P. David Baird, "Single-crystal lead magnesium niobate-lead titanate (PMN/PT) as a broadband high power transduction material," J. Acoust. Soc. Am., Vol. 121, 2591-2596 (2007).

6. J.C. Shipps and K. Deng, “A miniature vector sensor for line array applications,” Proc. OCEANS 2003, Vol. 5, 2367-2370 (2005).

7. The Undersea Dominance Road Ahead –FY05-11, ltr 9460 Ser N77/5S934212 of 03 Feb 2005 signed by ADM Walsh, then N77.

8. Capability Development Document for Communications at Speed and Depth was signed 27 March 2008; (Increment: 2; ACAT: III; Validation Authority: U.S. Navy; Approval Authority: U.S. Navy; Milestone Decision Authority: PEO C4I).

9. Capability Development Document for Acoustic Rapid COTS Insertion (ARCI) 2008-2014.

KEYWORDS: Communications at Speed and Depth, Digital Acoustic Communications, SSGN, ACOMMs, single crystal, cost-saving

N101-047 TITLE: Integrated Communications System-Next

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1D - VA Class & SBSD Submarine

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OBJECTIVE: Objective: Create a fully integrated and robust next generation Integrated Communication System (ICS-Next) that provides the internal communication infrastructure that supports the conduct of submarine tactical and non-tactical operations, both at sea and pier side. The ICS-Next should leverage current and emerging advances in shipboard networking, COTS communication components, and service oriented architectures, all of which are expected to significantly improve the flexibility to meet future shipboard communication needs and to reduce the submarine''s total cost of ownership (TOC).

DESCRIPTION: Current submarine interior communication systems are faced with limitations in reliability, ability to reconfigure, and supportability. Advances in communications technology using commercial standards and open architectures are expected to offer a significant improvement in functionality, reliability and on-board information exchange with a significantly reduced shipboard footprint, reduced installation costs and reduced sustainment costs. The next generation of interior communication systems should seamlessly communicate among all members of the crew the visual, audio, and operational information critical to ship safety, ship performance, and successful mission execution. A robust ICS-Next should take advantage of emerging commercial technologies and open architecture (OA) standards that promote advanced concepts of ship operation. The following ICS-Next features represent the principal R&D Challenges:

* Implementation for IA accreditation, encryption separation of voice and data communications and bridge between communication and tactical systems.
* Separation of voice/data domains for quality of service
* Compatibility of wireless technology with the submarine electromagnetic environment, power and frequency limitations and complete shipboard coverage without "dead spots"
* Peak loading capabilities, support of battle station and casualty communication loading.
* Integration of methodologies with the Tactical System (information transport, personnel paging, alerts, etc)

PHASE I: Investigate and specify an open architecture for the ICS-Next that meets current and emerging shipboard communication requirements including IA, that leverages shipboard fiber optic investments and that addresses the evolution to Service Oriented Architectures (SOA). Identify new and advanced technologies and commercial standards that will allow for the cost effective wireless communication and networking of ship communication devices, enables increased mission effectiveness, and enhances total ship management objectives. Provide an OA based approach that impacts TOC and addresses platform consolidation, system fault-tolerance, robustness, extensibility, and scalability.

PHASE II: Develop a prototype system that demonstrates the Phase I ICS-Next OA/SOA architecture and functionality that is compatible with shipboard environments such as the VA Block improvement program and surface combatant upgrades. Conduct an analysis of the acquisition, and total ownership costs for shipboard configurations

PHASE III: Design and implement a deployable OA/SOA-based ICS platform and functionality for Submarine and Surface Platforms. Evolve the ICS-Next architecture and design for backfit and new construction platforms to achieve TOC benefits through common system acquisition approach and implementation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial maritime environments (e.g. cruise ship, merchant marine), as well as industrial and power generation plants represent potential opportunities to offer ICS-Next functionality and SOA-based approaches as a COTS-based, cost reducing product.

REFERENCES:

1. "The CANES Initiative: Bringing the Navy Warfighter onto the Global Information Grid", By OPNAV N6, Cmdr. Phil Turner December 2007.

2. Consolidated Afloat Network and Enterprise Services (CANES) Industry Day by Program Executive Office Command, Control, Communications, Computers and Intelligence (PEO C4I).

3. SPAWAR N00039-09-R-0027 - Consolidated Afloat Networks and Enterprise Services (CANES) - SYNOPSIS / DRAFT RFP.

KEYWORDS: shipboard and interior communications; submarine integrated communications; CANES; ISSN; wireless networking; service oriented architecture

N101-048 TITLE: Environmentally Constrained Naval Search Planning Algorithms

TECHNOLOGY AREAS: Battlespace

ACQUISITION PROGRAM: PEO IWS 5 USW/DSS

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OBJECTIVE: To modify existing Navy Strike Group Route Planning and Asset Allocation Algorithms to automatically constrain naval search plans to avoid environmentally sensitive areas whenever possible.

DESCRIPTION: Modern mission planning tools output a) environmental characterization, b) the division of the search area among assets and c) search route alternatives based upon cumulative probability of detection (CPD). It is well known that asset allocation and search route definition are not unique, i.e. that there may be many routes and asset allocation plans that yield the same CPD. The goal of this work is to introduce environmental constraints into the mission planning process that allow naval platforms to avoid sensitive areas whenever possible. The plans output by the planning system would automatically select the route / asset alllocation plan which minimizes marine mammal impact without putting high value units at risk during search and transit.

PHASE I: Identify the environmental/protected species data bases and the search planning / asset allocation tool to be employed in tools like the UnderSea Warfare Decision Support System. Formulate the mathematical framework to be used in introducing environmental constraints.

PHASE II: Using the Advanced Processor Build (APB) concept, fully develop an interactive prototype of a standalone tactical decision aid to demonstrate proof of concept for environmentally constrained mission planning. Conduct lab testing and evaluation to ensure the tool works.

PHASE III: Deploy this prototype on an operational platform, support the at-sea testing, identify operational constraints and obtain end user feedback which can be used to improve the overall tool using the build-test-build concept. Fully integrate the tactical decision aid into the mission planning module of the Undersea Warfare Decision Support Software (USW-DSS). This fully integrated product should comply with USW-DSS protocols and user interfaces.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This software system has a direct application and is usable for the commercial fishery, oil and gas exploration (seismic), and marine construction industries where environmental compliance and determination of risk to protected species from their activities is necessary.

REFERENCES:

1. Letter of Authorization, Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Services, January 22, 2009.

2. Eddy, M.F., H Kribs, M. Cowen, Cognitive and Behavioral Task Implications for Three-Dimensional Displays Used in Combat Information/Direction Centers, Technical Report, March 1999.

3. Compliance Guide for Right Whale Ship Strike Reduction Rule (50 CFR 224.105), OMB Control #0648-0580.

KEYWORDS: Environmental compliance, Protected species, Marine Mammals, Protective measures, Risk assessment, Anthropogenic sources, Marine sanctuaries, Route Planning, Asset Allocation

N101-049 TITLE: Self Powered, Submarine Emergency Position Indicating Radio Beacon (SEPIRB)

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: Advanced Undersea Systems; Submarine Escape, Survivability & Rescue

OBJECTIVE: Development of an energy-harvesting emergency distress beacon for submarine use utilizing cutting edge technology that supports a programmable, pressure-proof, self power-generating unit that transmits on a frequency capable of being received by the COSPAS/SARSAT Satellite System.

DESCRIPTION: An energy-harvesting, self-powered emergency distress beacon is required to transmit GPS coordinates of a disabled submarine (surfaced or bottomed) via the COSPAS-SARSAT satellite system such that rescue forces can be activated to the datum location for rescue operations. The desire is for the self-powered beacon to be programmable by submarine survivors to send a situation report (SITREP) with vital information on the condition of the crew and submarine that will be used to help in the rescue. This programming capability to meet existing satellite BIT structure changes in the future. In order to be qualified for submarine use, the beacons must be pressure-proofed to 3000 fsw in accordance with P-9290 requirements (reference 3). The beacon should be capable of being deployed from a 76.2 or 101.6 mm (with adapter sleeve) signal ejector, or manually released via an emergency escape trunk. All preventative and corrective maintenance should be easily conducted by depot level repair facilities.

The beacons must able to maintain activation and provide GPS coordinates to the watch floors for a minimum of 48 hours. Any batteries designed for use in the beacon must be approved for submarine use and should provide no more than 25% of total power output. These batteries should provide minimum deployed shelf life of ten years prior to requiring replacement.

In addition, the beacons should be capable of being used by NATO allies in both size and circuitry.

PHASE I: Conceptual studies with design and drawings of options for the self powered emergency distress beacon. These studies would include the capability of meeting the energy generation and power output requirements via energy harvesting technology.

PHASE II: Development of a minimum of 2 scaled prototype units for evaluation within a controlled environment. This evaluation will include pressure testing to 3000 feet sea water and power output testing to ensure it provides sufficient energy in order to maintain activation and GPS signal acquisition for 48 hours. The concept proofing of these parameters will allow entry into the Phase III qualification and first article testing.

PHASE III: Upon successful completion of the Phase II effort the program office anticipates working with the firm and its manufacturers in order to procure a full scale prototype for real world testing within its intended environment. Once the R&D efforts have been completed the program office anticipates purchasing units for use within the Navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of a self-powered beacon could be used worldwide for all maritime and civilian purposes where an emergency positioning beacon would be desired or utilized.

REFERENCES:
1. http://www.cospas-sarsat.org/Beacons/BeaconReports/T-1630SRT%20Buoy%20Radio%20Transmitting%20SEPIRB.pdf

2. http://www.janes.com/articles/Janes-Military-Communications/SEPIRB-T-1630-SRT-expendable-submarine-launched-emergency-beacon-United-States.html

3. NAVSEA SS800-AG-MAN-010/P-9290, Revision A, ACN, System Certification Procedures and Criteria Manual for Deep Submergence Systems.

4. Photo of current SEPIRB, uploaded in SITIS 12/15/09.

KEYWORDS: submarine, emergency distress, beacon, search and rescue

N101-050 TITLE: Man Transportable Robotic System (MTRS) Remote Digger and Hammer Chisel

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS-408 Joint Service Explosive Ordnance Disposal (EOD), Man Transportable

OBJECTIVE: Develop a remote digger/hammer/chisel for the Man Transportable Robotic System (MTRS) to uncover ordnance and Improvised Explosive Devices (IEDs) encased in earth or concrete.

DESCRIPTION: Explosive Ordnance Disposal (EOD) operators require the capability to dig into hard packed soil and break up concrete with the MTRS. The MTRS is the number one tool used by EOD operators in their mission to inspect and render safe ordnance and Improvised Explosive Devices (IEDs) on the battlefield. The digger/hammer/chisel is needed because opposing forces mask IEDs and ordnance in packed soil or concrete curbs, buildings, and barriers.

The remote digger and chisel tool must be suitable for use on the MTRS. There are two robots under Government configuration control that are part of MTRS, the Robot, EOD, MK 1 MOD 0 and the Robot, EOD, MK 2 MOD 0. MTRS is based on two commercially available robotic systems, the iRobot Packbot™ and the Foster-Miller Talon™. Currently, there is little difference physically between the commercial and government configuration controlled versions, but these differences are subject to change. The Government will allow successful offerors limited access to the MTRS platforms based on priority and availability of the assets. Requesting companies should propose a universal solution that interfaces with either MTRS platform.

Currently EOD personnel use explosives to access IEDs concealed or buried in hard packed soils or concrete too hard for already available earth scraper tools to excavate. Using explosives is not ideal due to collateral damage inflicted on the surrounding area by the unearthing charge and/or the IED if detonated.

The innovation required is the design and development of a lightweight, robust, reliable impact tool suitable for use with the MTRS. The tool should be remotely activated by the robot operator via either MTRS Operator Control

Unit (OCU). The tool should universally interface with either MTRS platform, be easily removable at the user level, and negligibly affect the baseline performance of the MTRS.

The tool must be capable of unearthing buried ordnance and breaking up concrete within reach of the manipulators to expose concealed ordnance without causing the ordnance to detonate. The tool must generate the required force without damage to the MTRS.

The design is bounded by the footprint of the MTRS and lift capacity of the manipulators. The iRobot Packbot™ weighs approximately 60 lb. and the Foster-Miller Talon™ weighs approximately 120 lb. Both robots have a lift capacity of 15 lbs. at limited manipulator extension. The MTRS has a runtime requirement of two hours in a simulated operational scenario. The proposed tool must not degrade the runtime of the system below the two hour requirement. Required power for the proposed tool could be provided by either a standalone power source mounted on the MTRS or pulled directly from the MTRS provided it still meets the runtime requirement. These severe platform restrictions are too severe for any available off the shelf solution and will require new innovative approaches to the problem. Additionally, the final design should accent manufacturability and identify mean time between failures.

PHASE I: Design and model a tool capable of being carried by the MTRS that enables remote digging into packed soil and breaking up of concrete.

PHASE II: Design, build, test, and rework the prototype tool to produce a reliable, robust 2nd generation prototype with manufacturability in mind. Deliver multiple tools to the Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV) for system level test and evaluation.

PHASE III: Following successful T&E the final product would become an approved accessory for the MTRS and a fielding and support package would be formulated.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: One commercial application would be civilian bomb squads and first responders that use commercial equivalents of the MTRS. These commercial equivalents are the iRobot Packbot™ and the Foster-Miller Talon™.

REFERENCES:
1. http://www.irobot.com/sp.cfm?pageid=325

2. http://www.foster-miller.com/lemming.htm

KEYWORDS: Explosive Ordnance Disposal (EOD); the Man Transportable Robotic System (MTRS); Improvised Explosive Device (IED); robot; impact tool; buried ordnance

N101-051 TITLE: Simplified Topside Design and Assessment Tool

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: PMS 502, CGX Program

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a simplified analysis and budgeting tool that provides an approximate assessment of total ship radar cross section based on component level scattering data.

DESCRIPTION: The range at which Navy surface ships can be detected and targeted by adversary radar and missiles is dependent on the ship's radar cross section (RCS). Current modeling and simulation tools used by the Navy such as Ray Tracing Signature (RTS) are based on physical optics and theoretical diffraction software that require a detailed three dimensional model of the ship external geometry and topside mounted equipment and systems. This approach provides accurate predictions, however it is viewed as being time intensive (several months) to develop the models and then run the analysis. There is a need for a simplified, approximate analysis method that can be used during preliminary ship design phases that allows for rapid assessment of multiple design considerations and tradeoff studies.

This topic seeks to develop an advanced, innovative approach that provides an analysis tool capable of incorporating component-level scattering information, geometric blockage considerations and other primary signature drivers to aide in the development of an approximate signature prediction and detailed signature budget. A key challenge is going to be the ability to identify and define the key parameters that influence ship RCS and define an analytical and software approach for incorporating those parameters into a user-friendly modeling & simulation tool for signature analysis and budgeting. The goal is to have accurate and reliable assessments within weeks or days vice months and for solutions within 25% of a more exact RTS solution. Proposed concepts should have a user-friendly graphical user interface and must be capable of addressing signature prediction and budgeting corresponding to ship topside and combat system components as well as common hull, mechanical and electrical (HM&E) items.

Representative and relational data will be provided for this project during Phase II. The references below provide a generic description of RCS and it's applicability to ships (Ref 1) as well as approximate RCS values for various ships (Ref. 2 and 3) . All information provided and generated as a result of this effort will be unclassified.

PHASE I: Demonstrate the feasibility of an innovative approach for assessing total ship radar cross-section based on component level scattering. Establish performance goals of the approach and software tool. Provide a Phase II development approach and schedule that contains discrete milestones for product development..

PHASE II: Develop, demonstrate and fabricate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Perform documented, detailed verification and validation studies to assess the accuracy, speed, and repeatability of predicted electromagnetic behavior Develop a cost benefit analysis and a Phase III installation, testing, and validation plan.

PHASE III: Working with government and industry, complete development to include necessary user interfaces and instruction manuals. Work with Government subject matter experts to validate accuracy and limitations. Continue to conduct validation testing as appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This product will be useable and useful across the DoD components by government, commercial industry partners and civilian contractors.

REFERENCES:
1. RCS in Radar Range Calculations for Maritime Targets, Ingo Harre, (V2.0-20040206), http://www.mar-it.de/Radar/RCS/rcs.htm

2. Frigate LaFayette: The French Revolution in Ship Design, ASNE Symposium 1995

3. Williams/Cramp/Curts, "Experimental Study of the Radar Cross Section of Maritime Targets", Electronic Circuits and Systems, Volume 2, No 4, July 1978

4. Knott, E.F., Shaeffer, J.F., Tuley, M.T., Radar Cross Section, SciTech Publishing, 2003.

KEYWORDS: Radar Cross Section; Signature Prediction; Ships; Modeling & Simulation; Susceptibility

N101-052 TITLE: Novel Composite Pressure Vessel Structures With High Heat Transfer and Fire Resistance Properties

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS399 SOF Undersea Mobility Programs - ASDS and DDS

OBJECTIVE: Develop composite pressure vessels to house electronics and batteries (including large format lithium-ion cells) able to efficiently transfer heat, resist external pressures without collapse, and contain heat, pressure and combustion products without failing in the event of thermal runaway in up to three battery cells.

DESCRIPTION: Several types of submersibles, including the Advanced SEAL Delivery System (ASDS), house batteries and associated electronics in externally mounted pressure vessels. These pressure vessels are currently fabricated out of Titanium to minimize weight, but at a high fabrication cost. Many of these submersibles use Lithium-Ion systems that are more volumetric and gravimetrically efficient than other rechargeable battery systems, providing cycle life in excess of 200 cycles and 5 years wet life. However, energetic failure of a cell can result in damage to adjacent cells, to battery hardware, and ultimately to the host platform in the event the pressure vessel is breached. 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.

As batteries are charged or discharged, heat builds up in the cells, increasing the chance of thermal runaway of a given cell. Standard composite materials are not highly efficient at transferring heat.

This topic solicits a novel composite material and method of fabricating it into a pressure vessel that would maximize the transfer of any heat developed by the battery and electronics from within a composite pressure vessel to the ambient environment (i.e. seawater). Thermal conductivity shall be as close as possible to that of titanium. The pressure vessel must be able to do this while maintaining sufficient structural strength to withstand external collapse pressures, that is not implode. The external pressure varies, but the composite pressure vessel must be able to withstand pressure differentials (external to internal) of 1,000 PSI (threshold) and 1,100 PSI (objective). The composite vessel must also be able to withstand the heat and pressures resulting from energetic failure of up to three individual Li-Ion cells within the pressure vessel. For these Li-Ion batteries, the cell-level specific energy ranges from 150 to 200 Wh/kg and cell energy density ranges from 300 to 400 Wh/l. The offeror shall target cell sizes up to 500Ah. The pressure vessel must be able to contain all of the heat and pressure produced without failing and venting any products outside of the vessel.

PHASE I: Provide feasibility assessment of a composite material and pressure vessel design. Proposals that offer to survey existing composite material in Phase I will not be considered. Show that the material and design is scalable and will improve meet the safety requirements of pressure vessels containing large scale Li-Ion battery applications in high voltage (300 V) and high capacity systems (in excess of 1 MWh), without increasing weight significantly compared to Titanium pressure vessels. Analyze the design based on factors listed above, including pressure cycling resistance, weight, thermal conductivity, and fire resistance.

PHASE II: Implement and verify the design and concepts from Phase I in full-size pressure vessels capable of housing complete multi-cell Li-Ion modules and associated battery management system. Build prototype pressure vessels, and conduct proof-of-concept testing in a laboratory environment. This testing should include long term pressure cycle testing, and safety testing per reference 1 to assess the ability of the pressure vessel to withstand failures of up to three individual Li-Ion cells. Validate heat transfer efficiency and fire resistance of prototype systems. Develop one final Engineering Development Models (EDM) 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 system, including shock and vibration testing, and implodable volume testing per reference 2. 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: Lightweight composite pressure vessels that simultaneously protect contents from thermal overheating, fire and pressure would be applicable to any undersea submersible system, as well as potentially of interest to the space and airline industries.

REFERENCES:
1. SS800-AG-MAN-010/P-9290 System Certification Procedures and Criteria Manual for Deep Submergence Systems. Available for download at http://www.dodsbir.net/Sitis/view_pdf.asp?id=REF%20N093_194%20P9290%20Deep%20Sub%20Sys.pdf

2. Julie Banner, Mark Tisher, and Glen Bowling. "When Batteries Go Bad: '9310' Serious Testing for Serious Batteries," Joint Power Expo, New Orleans LA, 5-7 May 2009. http://www.dtic.mil/ndia/2009power/May6CJulieBanner/banner.pdf

3. Khairul Izman Abdul Rahim. "Wall Architecture of Pressure Hull," http://urrg.eng.usm.my/index.php?option=com_content&view=article&id=47:by-khairul-izman-abdul-rahim&catid=31:articles. (This article contains a number of references.)

KEYWORDS: composites; pressure vessel ; thermal conductivity; fire resistance; batteries

N101-053 TITLE: Low-cost Cabling Infrastructure for Naval Electronics Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Aegis Combat Weapons System (Non-ACAT) of DDG Class Ships (ACAT-1)

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop of an innovative approach to reducing cable counts via combining cables, use of new connector types, and bundled loops. Overall goal of the project is to allow major combat systems to achieve significantly reduced cable costs (e.g. >60% reduction).

DESCRIPTION: Modern Naval combatant ships are being designed with extensive network systems, often running into the thousands of network ports. Combat systems for naval ships are similarly leveraging networked equipment, and contain large amounts of cables using Fast Ethernet fiber technology. The current state-of-the-art technology is the use of individual copper cables or blown optical fiber, both of which are expensive. Current systems also have separate cables inside the electronics racks and between the electronics racks, which require two set of additional cables and large mil-Q connectors (which are also expensive). Blown Optical Fiber (BOF) infrastructure offered significant promise, but had durability problems in a shipyard environment and requires that products have separate electrical power cables (thus doubling the cable installation costs). Power-over-Ethernet technology requires copper cable-based network cables and eliminates the need for a separate electrical power cable, but so far system designs have not incorporated structured cable systems or aggregated/bundled cables to allow reduction in the amount of cables that a ship construction team had to install. Currently, the management of ship construction also includes inter-rack cables installed by shipyards which require electronics cabinets that have distinct backplanes with dozens of expensive connectors on them, so that the units are easily connected when installed. These connectors often become a significant cost driver, requiring a total of 4 expensive connectors for a connection between two cabinets.

This topics seeks to develop an innovative approach to cable dressing and connector design, leveraging data center structured cable products and stress relief loops or other innovative technology, to significantly reduce product and shipboard installation costs. Proposed concepts should address the overall reduction in cable counts via combining or bundling cables, use of newer structured connector types, and loop methods for stress relief. Concepts eliminate the traditional Mil-Q connectors on the rear of electronics cabinets and reduce line noise caused thereby allowing for higher bandwidth data rates are of particular interest. The significant technical challenge is to achieve adequate environmental performance in a shipboard environment without eliminating the cost advantage of the more modern approaches.

PHASE I: Demonstrate the feasibility of a Military Environment qualified Structured Cable System. Develop an initial conceptual design and establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Develop and demonstrate the prototype(s) as identified in Phase I. Through laboratory testing, demonstrate and validate the performance goals as established in Phase I. Refine and demonstrate the cable product designs for a Mil-Q structured cable system as well as the ability to operate with and connect to the Common Processor System, Common Enterprise Display System, Peripheral Input/Output, and Network cabinets for a Naval surface combatant application. Develop a cost benefit analysis and a Phase III testing, qualification and validation plan.

PHASE III: The small business will work with the Navy and commercial industry to complete any remaining qualification testing and refine the Cable Infrastructure products to meet tailored requirements of the sponsoring program, and expand the product line to provide other programs with variants to meet their requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector commercialization opportunities include Commercial Shipping and Fishing Fleet applications, mobile data server applications for emergency preparedness and response, and US Coast Guard Deepwater program uses.

REFERENCES:
1. Structured Cable systems: http://en.wikipedia.org/wiki/Structured_cabling

2. Naval Cables: http://www.nema.org/prod/wire/highperf/shipboard/

3. Naval Fiber Optic Shipboard Cable Technology Design Guidance: http://aero-defense.ihs.com/document/abstract/KHEAEAAAAAAAAAAA

KEYWORDS: Naval Networks, Structured Cable Systems, Computing Infrastructure, Cable connectors

N101-054 TITLE: Novel Methods to Improve Performance of Silver-Zinc Batteries

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS399/PMS-NSW ASDS, JMMS, SDV and SWCS

OBJECTIVE: To develop innovative large format Silver-Zinc cells and batteries that can provide total capacities in excess of 1 Mega-watthour (MWh) per cycle for greater than 36 cycles and two years of operation without requiring replacement.

DESCRIPTION: Silver Zinc (Ag-Zn) battery systems are more volumetric and gravimetrically efficient than many other types of rechargeable battery systems (such as Lead Acid). They even can provide close to the energy storage capacity of many types of Lithium Ion (Li-Ion) batteries as well, but do not carry the same level of risk of energetic failure of battery cells. However, the primary disadvantages of Ag-Zn batteries are their limited cycle and calendar life and low charge rates. Cycle life for the highest energy density designs can be below 20 cycles, and charge times of 36 to 72 hours are often required. These batteries also have the disadvantage of requiring systems to purge evolved hydrogen and oxygen gases. Recent research Ag-Zn batteries has not focused much on the large format batteries this topic covers.

Ag-Zn battery cells experience several failure modes that can likely be greatly reduced by novel membrane, electrolyte or electrode materials or coatings. This topic seeks innovative methods to improve the inherent efficiency and lifetime of very large scale Ag-Zn batteries. This solicitation seeks innovative improvements in battery and cell technologies that can be incorporated into large-scale Ag-Zn battery and cell technologies (e.g. possible alternate electrodes, electrolyte, or cell separator membrane materials) which reduce the likelihood and effect/ impact of cell failure modes (e.g. oxidation and degradation of separators, silver penetration, and zinc dendrite and oxalate crystal formation). Proposed improvements and modifications must be incorporable 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/service life targets in excess of 36 cycles and 5 years.

This solicitation also seeks innovative assembly-level and system-level approaches which can help increase the service life of these batteries (e.g. by performing cell balancing, improving cell packaging and thermal handling, or other similar operations). Approaches can include electronic, mechanical, chemical, thermal methods or otherwise, but should be applicable and effective in addressing the unique needs of high voltage (260 V) and high capacity systems (in excess of 1 MWh), while maintaining system-level specific energy in the range of 120 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, with multiple cycles performed while installed in the pressure vessels.

PHASE I: Perform basic research and development to investigate alternative electrode, electrolyte and/or separator materials that will greatly reduce the likelihood of potential cell failure modes. In a laboratory environment, conduct feasibility studies of proposed innovative new material or design concepts. Demonstrate by engineering analysis that the materials and design concepts are scalable, and will improve the efficiency, charge time, and life of large scale Ag-Zn battery applications in high voltage (260 V) and high capacity systems (in excess of 1 MWh/cycle), without sacrificing performance significantly. Analyze these designs based on factors listed above, including reliability, efficiency, weight, EMI considerations, size, charge time, and predicted cycle life, in addition to the inherent safety of the battery system itself. The Technology Readiness Level at the end of Phase I is expected to be TRL-3 at a minimum.

PHASE II: Implement and verify the design and concepts from Phase I in both bridge and full-size cells and bridge 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 similar to the tests listed in reference 1 to assess the safety and performance of the new design. Long-term cycle testing shall last at least 1/2 year prior to end of Phase II. Validate efficiency and energy and power density storage of prototype systems. Develop final Engineering Development Model (EDM) multi-cell module capable of being tested in a shipboard environment (NOTE: testing in a real-world environment will not be conducted during Phase II). The Technology Readiness Level at the end of Phase II is expected to be TRL-6.

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 battery 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 component and technology improvements sought here could be useful in commercial applications where high energy density is the main driver for energy storage needs. Examples would be space applications, ocean exploration, offshore oil rig inspection, UAVS, and robotics.

REFERENCES:

1. Karpinski A. P., Makovetski B., Russell S. J., Serenyi J. R., Williams D. C. “Silver-zinc: status of technology and applications,” International Power Sources Symposium No21, Brighton, ROYAUME-UNI (10/05/1999) 1999, vol. 80, no 1-2 (331 p.) (7 ref.), pp. 53-60. http://cat.inist.fr/?aModele=afficheN&cpsidt=1862607

2. James Skelton and Roberto Serenyi. “Improved silver/zinc secondary cells for underwater applications,” Journal of Power Sources, Volume 65, Issues 1-2, March-April 1997, Pages 39-45. The 20th International Power Sources Symposium. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TH1-3S9K2PW-9&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1016811904&_rerunOrigin=scholar.google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=897b7293dce423450654106b3f368cb8

3. R. M. Dell. “Batteries: fifty years of materials development,” Solid State Ionics Volume 134, Issues 1-2, 1 October 2000, Pages 139-158. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TY4-41J69KY-H&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1016813108&_rerunOrigin=scholar.google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=529ef2dfd29c449a3b08d1f94d8872bc

KEYWORDS: Silver; Zinc; Battery; Capacity; Cycles; Safety

N101-055 TITLE: Advanced Power Management for In-Service Combatants

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 400F, Fleet Support Office

OBJECTIVE: Develop an advanced power management system including the associated algorithms, control programming, and human interfaces that will provide the capability to monitor and adjust energy generation sources, energy storage, and dynamic loads for enhanced shipboard distribution performance.

DESCRIPTION: PMS 400F is leading efforts with NSWCCD (Philadelphia, PA) to further reduce the Navy’s reliance on fossil fuels while increasing energy efficiency of the DDG 51 Class. Hybrid Electric Drive (HED) will be used to improve DDG 51 Class ship fuel efficiency during normal cruising and enables increased mission load power for future warfighting capabilities. In Electric Propulsion System (EPS) mode, the system will be designed to drive both shafts utilizing electric rotating machines attached to the Main Reduction Gears (MRGs) at ships speeds up to approximately 13 knots without the use of the LM2500 Gas Turbine Main engines (GTMs). In Propulsion Derived Ship’s Service (PDSS) or generation mode, the system will use the attached motors as generators, powered by the GTMs via the MRGs, connected to the electrical distribution system. Operating the HED in PDSS mode provides the redundancy required to secure one of the typically two on-line 501K Ship Service Gas Turbine Generator (SSGTG), providing additional fuel efficiency.

As the HED system with future potential in energy storage is developed and implemented, the propulsion load will become hybrid in that the propulsion power can be provided by either mechanical or electrical means through the motor attached to the MRG. The electrical distribution will also gain a variable source of energy on the bus. As this capability is integrated into the ship, the ability to monitor and control power from various will need to be capable of automatic and manual operation and monitoring. The current state-of-the-art in configuration and control methodology segregates the operation of the propulsion and ship’s service loads. With the current state-of-the-art technology solutions, it is not possible to use the ship service generators to supply propulsion power or tap into the propulsion power to provide electrical power. The ability to integrate and “share” power sources would allow for more efficient power generation, utilization and management of the available power sources onboard naval ships.

This topic seeks to explore innovative methods, processes and the associated technologies necessary to develop an advanced power management system. This includes the associated algorithms, control programming and human interfaces that will provide the capability to monitor and adjust energy generation sources, energy storage and dynamic loads for enhanced shipboard distribution performance. A key technical challenge is going to be the ability to monitor and control multiple types and sources of power with different peak-powers and operating profiles. For example, energy storage devices are going to try to keep the voltage at a pre-determined level to prevent brown-outs. Energy generation is going to try to provide long-term load adjustments. If the energy storage devices absorbed all of the short term transients, your energy generation system would likely not know of a power fluctuation and might potentially not respond until energy storage reserves run dry. The proposed concepts should be able to interface and integrate into the ship’s existing control and monitoring framework, Integrated Condition Assessment System (ICAS) as well as the Full Authority Digital Controller (FADC) which is responsible for controlling the load sharing between generators. Proposed concepts should be able to handle variable source power, ensure capability of operation by single crew member, assure that each load is being used optimally, and easily display the current state of the plant operation.

This system could be deployed to the existing fleet to ensure the ship’s propulsion/distribution are utilized effectively and enable the efficient operation of variable sources of power. In the future, upgrades of this system may be required to work with a variety of stored energy sources such as fuel cells, flywheels, and other renewable energy resources. For this reason, the approach proposed should employ the use of open architecture principles as practicable.

PHASE I: Demonstrate the feasibility of the monitoring interface and control system that will provide the interfaced capability to monitor and adjust varying dynamic sources and loads. Where applicable, develop computer models that will demonstrate the feasibility, performance, and modes of operation of the proposed concept. Establish validation goals and metrics to analyze the feasibility of the proposed solution and provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Finalize the design concept from Phase I and fabricate a prototype in order to evaluate the developed algorithms and strategies. Validate prototype capabilities in laboratory testing and provide results. Demonstrate proposed installation, maintenance, and performance of the monitoring interface 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 on a DDG-51 Class destroyer. 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: As industrial power generation operations will rely relying more on multiple dynamic alternative energy sources, such as solar, hydro, and wind power, along with energy storage technologies, their ability to balance and monitor complex grid systems, will grow past their ability to build a power management system that will be cost effective for their operation. 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. Large Wind Integration Challenges and Solutions for Operations and System Reliability, Presented to IEMDC 2009 Conference by Bart McManus of Bonneville Power Administration

5. ICAS Web site: https://icas.navsses.navy.mil/ (accessible without username/password)

KEYWORDS: Energy Efficiency; Power Management; Distributed Generation; Energy Generation; Energy Storage;

N101-056 TITLE: Compact and/or MEMS-based gas-sampling sensors for analysis of battery offgassing

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS 399

OBJECTIVE: Design and demonstrate highly compact (possibly MEMS-based) sensor devices, suitable for robust, reliable monitoring and sensing of gases indicative of battery degradation and release, and/or offgassing due to typical operation. The device is designed to observe the release of electrolyte from a damaged or compromised lithium-ion battery, but would also be usable to monitor offgassing of other battery technologies due to the desired species which the device should be able to determine. The device should have good dynamic range of operation, and be suitable for mounting in tight places with minimal accessibility and power requirements. The devices should also offer long life with minimal interface required, and be available at relatively low cost so that they can be utilized in high volume.

DESCRIPTION: Energy storage is becoming more and more critical to the enabling of advanced electrical architectures on ships, and is also of very high utility for use in combination with other high-efficiency systems such as fuel cells. Advanced lithium-ion batteries offer significant benefits in terms of capacity, discharge characteristics, and volumetric and gravimetric power and energy densities. However, lithium-ion batteries, like most other energy storage systems, have a variety of safety concerns, particularly if placed in an enclosed space in a means that cannot readily be removed, disposed, etc.

As a means of risk mitigation, it is critical to be aware of battery breakage, leakage and other means of degradation or compromise, through multiple, redundant means to ensure safety. A critical aspect of the redundant, interlocked safety analysis is that of monitoring the atmosphere around the units, which may or may not include lithium-ion , lead acid, silver-zinc and other battery types, to determine the presence and concentration of gases of interest, including VOCs, CH_4, CO/CO_2, HF, hydrogen, H_2S/SO_2 etc., in air that is typically between 40-140F and ambient pressure. Typically, sensor systems for environmental monitoring and specialty analysis of such gases have been large, especially if hardened and militarized for diverse applications. The typical set of devices also is generally based upon chromatographic and/or spectroscopic technologies which are relatively large in size. Recent systems, while tunable to be sensitive to the gas sets desired, still are of a size and architecture that does not enable highly redundant sensing and on-location determination of the content and concentrations of interest. The combination of a gas sampling device coupled to the sensor, data bus, processing and data analysis, energy storage, etc. creates a system that is too large for broadly distributed application throughout a cabinet or set of cabinets or similar installation.

Recent developments in advanced sensor technology and MEMS device design and operation make it potentially possible to have extremely small, low power draw devices that can exist at relatively low cost compared to traditional technology. Additionally, with miniaturization and "sensor on a chip" technologies advancing quickly, it provides the opportunity to perform multiple applications in a tiny package, further increasing redundancy and distributed safety analysis. As a result, the compact or MEMS sensor should not take up a space larger than 36in^3, and no larger than six inches in any one dimension. It is preferable for a smaller package to be provided, to whatever minimal scale is possible, should technology permit.

Of key interest to this effort is the ability to operate and detect trace levels of the gases described, while maintaining good dynamic range, reliability and calibration for durations in excess of one year. This minimizes the labor and upkeep costs, while also ensuring that these sensors, which may be placed in very tight, difficult spaces, are not a liability to the safety system operation. Also, because of potential placement and desired minimization of interfacing and requirements, the system should be relatively self-contained, and require no outside utilities or equipment (e.g. air, water, vials, syringes) that it cannot self contain for the duration. An ultimate sensor device should be rugged and robust in design, capable of existing in wet environments with salt air.

General specifications are as follows:
Size: Small as possible, threshold 2”x3”x6”
Weight: 900g
Gas detection: VOC, CH_4, CO, HF, H_2 (threshold); Additionally H_2S, SO_2, CO_2, O_2 (objective)
Typical response to any gas: <18 seconds
Typical sensor life: >5 years
Calibration longevity: >1 year
Audible Alarm: piercing, 85dB at 1m
Visible Alarm: verification of operation, fault, and presence of gas (option to describe specific gases and concentration value)

PHASE I: Demonstrate proof of concept for sensing the gases described above. The device need not sense all gases on one chip/unit, but it is preferable to demonstrate multiple gases determined from a single unit. Proof of concept should be from moderate ppb range (e.g. 250ppb) through low ppm range (e.g. 25ppm), or higher. The device can operate with whatever power source is required for a prototype, but should ultimately be designed for 24 or 48VDC input.

PHASE II: Develop an integrated prototype device that offers multiple sensor technologies on one chip/unit, and operates via a standard interface, such as LabView (with a more advanced interface designed under an option phase). The device itself should have a self-contained indicator of operation, and an indicator of conditions or presence of specific gases. The integrated device should show a good linear range of at least that shown in Phase I, preferably wider, with increased sensitivity to low-levels of the gases desired. The sensor operational characteristics shall be demonstrated in a controlled environment consisting of a lead-acid battery under charge (with release of hydrogen), with controlled input of a variety of low-level test gases including HF and VOCs relevant to the compromise of a lithium-ion battery.

PHASE III: Advanced sensors are in increasingly high need for a wide variety of applications, and it is anticipated that these sensors will be of use for monitoring release and atmosphere as lithium-ion batteries are utilized for applications such as hybrid vehicles and distributed grid-tied energy storage. Phase III should focus on militarization of the system, and providing compatible interfaces, including a self-contained indicator system, as well as a compact communication means via CAN bus. The sensors should be demonstrated in its final form in a controlled atmosphere as described in phase II, as well as in conjunction with a platform which routinely handles charging of batteries which are known to offgas hydrogen.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Sensors to monitor the release of batteries have applicability for applications ranging from hybrid cars to battery backup for telecommunications and grid stabilization. The products potentially released from batteries as they degrade, as well as from some battery varieties simply as they undergo charge, etc. is of high importance for monitoring and health/operation assessment, as well as safety.

REFERENCES:
1. Winchester, C., Kiernan, D., Lithium Battery Safety, Good Batteries Gone Bad. Joint Service Power Expo, 5 May 2005.

2. Charles J. Scuilla, The Commercialization of Lithium Battery Technology, S9310-AQ-SAF-010.

KEYWORDS: Sensor; MEMS; Battery; Safety; Gas; Vapor

N101-057 TITLE: Innovative Submersible Outboard Cable Failure Detection and Prediction Device

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: NAVSEA PMS435 - AN/BLQ-10 and PEOC4I PMW770 - Sub High Data Rate Antenna

OBJECTIVE: Develop a novel approach using innovative research and development to detect potential sources of failure in and evaluate the condition of multi-conductor (i.e., copper pins, copper coax, and fiber) cables.

DESCRIPTION: There are specialized outboard electrical cables which link masts or sensors to their outboard electrical hull fitting. These cables can vary in length and complexity within different applications and classes of submarines. Many programs use these specialized electrical outboard cables including Communications, Imaging, Electronic Warfare, and Sonar. These cables are used in other military and commercial applications as well. During operations, these outboard cables can develop kinks, fractures, or breaks in some of the conductors which eventually lead to system failure.

Currently, cables are checked only for continuity and resistance readings. This method does not detect whether any of the strands in a wire are broken; or whether a coaxial conductor is fractured. Broken strands in a wire could lead to cable failure in a matter of days, or weeks, depending on the severity of the wire fatigue. Unless the wire is completely broken, continuity may still be verified. There is currently no device capable of detecting potential failures and predicting the life expectancy of outboard cables that are day in and day out subjected to harsh environments. Periodic inspection of outboard multi-conductor cables with a means to identify potential failures will allow the Navy to predict the service life and replace cables before a complete open-circuit failure occurs during at-sea operations.

A non-destructive test set is desired, that shall be able to evaluate the health of, and pinpoint potential failures in any submerged cable (whether on a submarine or other submersible craft); including cables that may be exposed to extreme temperatures, high hydrostatic pressure, bending, or any other external force that may decrease the useful life of the cable. It is desired that this unit be handheld and that a single person be required for operation. It is also desired that the unit be ruggedized as its primary use will be at shipyards during installations and shipchecks prior to underway periods.

An example of the types of failures this device should detect and predict, are the failures being seen with the SubHDR Dip Loop cable. The SubHDR Dip Loop cable is an outboard electrical cable linking the Submarine High Data Rate mast to its electrical hull fitting. During operations, the SubHDR Dip Loop Cable develops z-kinks in some of the conductors which eventually lead to open – circuit breaks, and system failure. It is thought that conductor kinks occur during the operation of the mechanical handling system; however, the root cause has not been identified.

PHASE I: Conduct research to develop a novel approach to detect potential failures, particularly kinks, fractures, and breaks as well as predict life expectancy in outboard multi-conductor cables. Results from Phase I should include initial design schematics, preliminary control software and prediction algorithms, and anything else that would indicate the production of a prototype detection and prediction device during Phase II is feasible.

PHASE II: Based on the outcome of the Phase I effort, develop a scaled prototype to be evaluated within a controlled environment to detect and predict outboard cable failures. The prototype should be able to evaluate new multi-conductor cables for quality control as well as inspect existing cables for fatigue from use. The prototype should also be able to demonstrate its predictive algorithms used for service life estimates.

PHASE III: Upon successful completion of the Phase II effort the program office anticipates working with the firm and its manufacturers in order to procure a full scale prototype for real world testing within a shipyard environment. Once the R&D efforts have been completed the program office anticipates purchasing units for use within the Navy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Other potential applications include other branches of DOD with in service multi-conductor cables, commercial industries such as telecom, and automated systems using multi-conductor cables.

REFERENCES:

1. Sub-cycle detection of incipient cable splice faults to prevent cable damage; Kojovic, L.A.; Williams, C.W., Jr.; Power Engineering Society Summer Meeting, 2000. IEEE Volume 2, 16-20 July 2000

2. Application of thermoelectric aging models to polymeric insulation in cable geometry; Cooper, E.S.; Dissado, L.A.; Fothergill, J.C.; Dielectrics and Electrical Insulation, IEEE Transactions on [see also Electrical Insulation, IEEE Transactions on] Volume 12, Issue 1, Feb. 2005

KEYWORDS: SubHDR; Dip Loop; Cable; outboard; break; z-kink; multi-conductor

N101-058 TITLE: Application of Coatings for Complex Ship Structural Surfaces Using Electrostatics

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 500, DDG 1000 Program, ACAT 1

OBJECTIVE: Develop and demonstrate an approach and the associated technology(ies) usable with a range of surface coating systems that will allow for the application of a uniform coating thickness to complex surfaces using electrostatics.

DESCRIPTION: Coating failures tend to occur most rapidly in areas of geometrical irregularity on corners and edges. While the Navy has invested in edge retentive coating systems, application procedures still require the application of multiple coats (primer, stripe coat on edges and corners, and a topcoat) due to the challenges inherent in coating complex surfaces. The current naval practice requires the application of multiple coats (or in some cases a single thick coat) with extensive quality assurance checks and coating touchup in thin areas to ensure that there are no exposed areas that would be susceptible to corrosion. The need for multiple touchup applications to ensure adequate coverage directly translates to increased labor and materials costs. Many of the areas that need remedial coating application are in the areas of geometric irregularity.

This topic seeks the development of an approach to reliably deposit a uniform coating at a controlled thickness on complex surfaces using electrostatics. The reliable application of a uniform coating could eliminate the need for substantive additional applications of paint to the complex areas that are difficult to reach using conventional coating processes. This would directly translate to an appreciable saving in labor costs. Areas of particular challenge are in tanks and voids where stiffeners, piping, and supports create areas that are nearly inaccessible to conventional coating spray equipment. Electrostatics would take advantage of the steel substrate of the coating application to promote adherence to complex shapes and to areas that are out of the line of sight, such as behind I-beams. The specific electrostatic method chosen must be compatible with the existing range of surface coating systems. For the purposes of demonstrating concept feasibility, initial developmental emphasis should be upon coating systems (primarily epoxies) currently in use in the naval shipbuilding industry such as those qualified to MIL-PRF-23236. The proposed process must be operable in an industrial shipyard environment and must be portable to allow for operation in remote ship spaces by no more than two people.

PHASE I: Demonstrate the feasibility of the application of a uniform coating thickness to complex structures using electrostatics. Establish performance 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/prototype development

PHASE II: Develop a prototype of the proposed Phase I concept(s). Using laboratory characterization experiments, validate the performance goals identified in Phase I. Provide manpower, cost-savings and performance metrics. Prepare an implementation and test plan that contains discrete milestones for product development for the purposes of obtaining necessary certifications for shipyard and/or manufacturing sector implementation.

PHASE III: Utilizing the concept(s) developed during Phase I and Phase II, work with Navy and industry to approve and certify the proposed concept for use in Navy applications and then transition this technology to existing and future surface combatant systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would have a broad range of applications in commercial industries such as manufacturing, automobile, construction (infrastructure applications, bridges, etc.) and commercial shipbuilding.

REFERENCES:
1. Kaznoff, A.I. and Brinkerhoff, B., “The Future of Marine Tank Coatings-A U.S. Navy Perspective”, Journal of Protective Coatings & Linings, Vol. 22, No. 2, Feb 2005, pg 40-44.

2. MIL-PRF-23236C, Performance Specification, Coating Systems For Ship Structures, Aug 2003. http://assist.daps.dla.mil/online/start/

KEYWORDS: coating; structures; application; automation; corrosion control

N101-059 TITLE: Ultra Wide Bandwidth High Dynamic Range Digital ISR Receivers for the submarine force

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: AN/BLQ-10A(V) Submarine SIGINT Collection Suite -- ACAT III

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop an innovative Ultra-wideband (>20 GHz instantaneous processing Band Width (BW)) high dynamic range (>75 dBm) radar wideband subsystem that cannot easily be captured by Continuous Wave (CW) signals, dense environments or complex emissions.

DESCRIPTION: The current radar wideband subsystem of the AN/BLQ-10 A(V) SIGINT suite is based on Instantaneous Frequency Measurement (IFM) /Digital Frequency Discriminator (DFD) technology and is easily “captured” by CW, extremely high duty cycle signals or very dense environments. The ability of this system to perform against very complex emitters is degrading.

While bits and pieces of technology solutions exist in various stages of development, no total engineering solution exists. Consequently, an innovative, extremely wideband system must be developed to provide 100% Probability of Intercept (POI) in today’s dense and complex environment without providing ambiguous or erroneous reports. The total SBIR project will provide a solution that has improved the Mean Time Between Failures (MTBF) (> 500 hour improvement), reduced the total vertical footprint (< 12 U total), cut power and weight by over 1/3 the current subsystem, and, finally, reduce the recurring cost of the Radar Wide Band (RWB) subsystem by at least 20%.

The current signals that are problem sets are: extremely short and extremely long pulse width (PW) signals (PW's less than 30 nanoseconds and greater than 512 microseconds wide); signals with Pulse Repetition Interval (PRI) agilities (staggers – greater than 64 positions, jitters – greater than 40%, discrete jitters – greater than 64 positions, micro-jitters, switch and dwells, and pulse code modulation); signals with Frequency agilities (intra-pulse Frequency Modulation (FM) (linear and non-linear FM, phase coding), and inter-pulse FM (jitters, multi-tone, pulse to pulse frequency shifts, switch and dwells, and phase code modulation); solid state transmitters, multi-beam signals, electronically scanned emissions, and emissions showing agility in multiple simultaneous dimensions.

Because of the environment the submarine operates in, extremely high dynamic range is crucial especially as systems operate over extremely large bandwidths. Maintaining sensitivity requirements in the presence of powerful emitters mandates dynamic ranges greater than 75 dB. When operating in the presence of strong signals the wideband detection systems must still detect the low power emissions.

PHASE I: Develop a conceptual design for a hardware and software approach for showing a 100% POI Design that has an instantaneous RF bandwidth of greater than 20 GHz with a multi-tone dynamic range of greater than 75 dB. This concept must operate in an environment that requires a pulse throughput of greater than 5 million pulses per second.

PHASE II: Design, Fabricate and test a lab demonstration of the hardware and software mechanism designed in Phase I. Testing must be performed under controlled real world conditions.

PHASE III: If successfully demonstrated in Phase II, develop and install the demonstration asset on a submarine for at sea testing and demonstrations. If successful and evaluated at a TRL of 7 or higher this capability will be transferred into the AN/BLQ-10 (V) as part of the Program of Record (POR).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Harbor surveillance for homeland security and law enforcement surveillance are possible commercial applications of such devices.

REFERENCES:
1. Fundamentals of Statistical Signal Processing, Vol. 1; Prentice-Hall, Steven M. Kay, 1993

2. HTTP://www.SharpEye.biz/sharp/index.php

3. The Beginnings of Solid State Radar, Hyltin, T.M.; IEEE Transactions on Aerospace and Electronic Systems, Volume 36, Issue 3, Part 1, July 2000 Page(s):1016 - 1019

4. R. Wiley, The Analysis of Radar Signals, 2nd ed. London, U.K.: Artech House Press, 1993

KEYWORDS: electromagnetic propagation; radar narrow band; radar wideband; compressive receivers, delay lines

N101-060 TITLE: Advanced, Automated Sensing and "3-D" Control/Targeting System for Exterior Shipboard Fires

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS 500, DDG 1000 Program, ACAT 1

OBJECTIVE: Development of advanced automated sensing and control/targeting system, including fire initiation detection and "3-D" localization. This will enable the rapid detection and localization of exterior shipboard fires involving composite/ flammable materials located on a deckhouse to support an automated firefighting response.

DESCRIPTION: The threat of fire is increased in new ship designs because the superstructure is made of composites and coated with materials, which are also flammable, that help to reduce ship signatures. Suppressing exterior shipboard fires involving deckhouse materials that can rapidly burn requires an automated sensing and targeting capability that does not rely upon an operator to assimilate data to determine where and when the fire started. The current state-of-the-art in sensor technology does not support localization of a fire which, once determined, can then be used to automatically or autonomously target and aim a fire fighting agent response. Currently available sensors will provide either early warning (e.g. smoke) or a total flooding response (e.g. optical flame detector or a heat detector in a magazine detects flame/heat), but the response is then a total flooding of the space.

External fire sensors are not currently used on naval ships and are a challenging problem for the following reasons:
(1) There are no topside passages outboard of the superstructure; therefore, there is no easy method of accessing the topside.
(2) The sensors must withstand environmental and weather factors. The current state-of-the-art sensors are not operable in this application.
(3) The area of coverage required is large, yet the requirement is to be able to precisely detect and localize a fire to enable an immediate and prompt casualty response.
(4) The sensors must address and not degrade the signature control issue.

This topic seeks innovations and alternative approaches to the development of advanced, automated sensing and control/targeting techniques, including fire initiation detection and “3-D” localization which will significantly reduce the risk of an out-of-control fire involving the deckhouse. The desire is to be able to provide a continuous, automated, exterior, fire detection capability as well as support the precise targeting or localization of the fire. It is envisioned that these sensors and associated algorithms would be included as part of the overall ship control system and would initiate an overall fire suppression system response. Proposed solutions will need to be able to detect fires up to several hundred feet depending on their installed location and will have to operate in an automated fashion and under environmental conditions that may impair visibility such as smoke, fog, salt spray, temperature range extremes or night-time operations. The proposed solution would also need to be able to maintain real-time feedback capability once the monitor stream is activated, be immune to false alarms under the above stated conditions, and be able to detect fires involving Class A or Class B materials. It is anticipated that for some sensor technologies the sensor may be affected by the fog stream itself.

PHASE I: Demonstrate the feasibility of an innovative approach to the development of a sensor system that supports automated fire detection and targeting for fires that can be initiated anywhere on a “typical” deckhouse structure. Develop an initial conceptual design and establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Develop and demonstrate the prototype(s) as identified in Phase I. Through laboratory testing, demonstrate and validate the performance goals as established in Phase I. Refine and demonstrate the capabilities of the system. Simulated environmental conditions and fire/ firefighting effects should be included in the demonstrations. Conduct life cycle and environmental testing. Develop a cost benefit analysis and a Phase III testing, qualification and validation plan.

PHASE III: The small business will work with the Navy and commercial industry to commercialize the fire detection system with a design that meets the Military Specifications for shipboard use. Demonstrate the system in realistic, full-scale fire tests. The fire detection systems shall be UL listed and Mil Spec qualified.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This concept could have application for the protection of minimally-manned shore-side facilities (e.g., electrical sub-stations) and monitoring secure areas.

REFERENCES:
1. Sorathia, U., Kiviat, B., and Lattimer, B., “Fire Safety Goals and Material Performance Criteria for Composites Considered in the Topside Applications on Surface Ships,” NSWCCD-64-TR-1999/01, November 1999.

2. White, D.A., Scheffey, J.L., Sincaglia, P.E., Farley, J.P., Williams, F.W., “Advanced Enclosed Mast/ Sensor System Fire Hazard Analysis,” NRL Ltr Rpt 6180/0316, 25 July 1996.

3. White, D.A., Scheffey, J.L., Farley, J.P., Williams, F.W., "LPD17 Amphibious Dock Ship: Fire Hazard Assessment of the Forward and Aft AEM/S System Masts," NRL Memorandum Report 6180-00-8467, 26 June 2000.

4. Rollhauser, C.M., "Composite Fire Hazard Evaluation for the Integrated Technology Deckhouse," DTRC/SME-89/03, David Taylor Research Center, Bethesda, MD, February 1989.

5. DDG-1000

KEYWORDS: Fire-fighting; damage control; sensors; control algorithms; automated; deckhouse

N101-061 TITLE: Multi-Algorithm Unique Emitter Identification

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

ACQUISITION PROGRAM: PMS-435 Submarine Tactical EW System AN/BLQ-10(V) - ACAT III

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop innovative algorithms and multi-algorithm fusion techniques for submarine EW/ISR system to support unique emitter identification. The need is to develop this technology with operator workload reduction being paramount. Any automation techniques must ensure an extremely high degree of confidence in accuracy of reports.

DESCRIPTION: The recent emergence of diverse and complex non-magnetron based solid-state radars into the commercial maritime market presents a future challenge to submarine situational awareness. As manufacturing technology matures and costs decrease, technically advanced radars are expected to be utilized more and more in shipborne maritime navigation systems as well as in land based coastal surveillance applications. Timely and accurate situational awareness of surface activity is crucial to ensuring safe passage, maintaining tactical superiority and asserting control in underwater operations. Passive techniques that detect and uniquely identify technologically advanced radars based solely on the analysis of their emissions are sought. Open multi-algorithm solutions are anticipated based on the expectation that no single technique will perform uniformly best against all present and/or future radar systems. Specific identification algorithms shall be developed as well as methodologies to fuse multiple algorithms for the purposes of enhanced identification performance. The need to reduce the operator workload is paramount, so the need for automation with an extremely high confidence level for correct identification is critical.

PHASE I: Develop identification algorithms for specific identified target emitters and develop an overall open architecture/methodology to fuse the results of multiple algorithms. Provide proof-of-concept via simulation demonstrating that multiple algorithms provide an overall identification performance benefit while guaranteeing an extremely high confidence of accurate reports.

PHASE II: Choose three or more algorithms and a computational architecture for their implementation to yield a demonstration system that works with 1 GHz intermediate frequency signals. Develop interface control software that allows intuitive operation of the system. Develop Automation Techniques that minimize operator interaction while guaranteeing an extremely high confidence level of accurate reports.

PHASE III: If successfully demonstrated in Phase II, develop and install devices of this type on a submarine platform as part of a technology demonstration. If the demonstration is successful and TRL levels are assessed to be greater than 7 then the capability will be transitioned to the AN/BLQ-10 program of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Passive tracking of advanced RF devices has application in personnel tracking, cell phone monitoring and identification verification.

REFERENCES:

1. Fundamentals of Statistical Signal Processing, Vol. 1; Prentice-Hall, Steven M. Kay, 1993

2. HTTP://www.SharpEye.biz/sharp/index.php

3. The Beginnings of Solid State Radar, Hyltin, T.M.; IEEE Transactions on Aerospace and Electronic Systems, Volume 36, Issue 3, Part 1, July 2000 Page(s):1016 - 1019

4. R. Wiley, The Analysis of Radar Signals, 2nd ed. London, U.K.: Artech House Press, 1993

KEYWORDS: Identification, Detection, Tracking, Algorithm Fusion

N101-062 TITLE: Improved Torpedo Defense

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS-415: Anti-Torpedo Torpedo Defense System: ACAT II

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop innovative technology to resolve closely spaced approaching torpedo salvos near end-fire of towed sensors.

DESCRIPTION: A difficult technical challenge for surface ship torpedo defense is the spatial resolution of closely spaced multi-torpedo salvos. Passive detection and localization are typically done with towed line arrays, which have been shown to localize well and resolve multiple targets near broadside with state-of-the-art processing (see reference 1, chapter 9). Target resolution near end-fire is much more difficult because of the broader line array beamwidths, and the inability to use wavefront curvature or triangulation with hull-mounted sensors. Innovative approaches are solicited.

The objective of this topic is to perform R&D that will clearly establish the technical feasibility of end-fire salvo resolution. Torpedoes are typically loud passive acoustic emitters with significant broadband energy from 0- 30 kHz. (Reference 3 describes typical broadband signatures of ocean vehicles.) Satisfactory performance would provide resolution of targets separated by 50-100 yards at ranges of 1000-5000 yards.

Proposed techniques may include innovative passive signal processing techniques, model-based approaches, matched field processing (reference 2), exploitation of acoustic propagation effects, Doppler, etc. The Navy’s primary interest is in towed array solutions but multi-sensor (tow ship sonar and towed array) solutions are also of interest. Significant flexibility in proposed approaches will be accommodated.

Spectral identification or other exploitation of classified torpedo signature information is not required to address this topic.

PHASE I: Describe the proposed approach for end-fire salvo resolution and conduct analysis to show feasibility of the approach.

PHASE II: Design and build a prototype of the proposed salvo resolution technique for evaluation. Evaluate performance on the prototype using synthetic or recorded data.

PHASE III: Conduct full scale testing of the technique in an operational environment such as a sea test. Integrate successful improvements into Navy torpedo defense systems (e.g., ATTDS, AN/SQQ-89).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATION: This technology can be applied to commercial applications in which detection and resolution (separation) of multiple objects is required using sensor arrays. Commercial applications would include array-based cell phone signaling, seismology, medical imaging and law enforcement (gunshot detection/localization).

REFERENCES:
1. H.L. Van Trees, Optimum Array Processing. Wiley, New York, 2002.

2. A.B. Baggeroer, W.A. Kuperman, P.N. Mikhalevsky, “An Overview of Matched Field Methods in Ocean Acoustics,” IEEE J. Oceanic Eng, vol.18, No. 4, October 1993.

3. R.J. Urick, Principles of Underwater Sound, McGraw Hill, New York, 1983.

4. A.B. Baggeroer and H. Cox, Passive Sonar Limits upon Nulling Multiple Moving Ships with Large Aperture Arrays, 33rd ASILOMAR Conference on Signals Systems and Computers, Vol. 1, pp. 103-108, 1999.

KEYWORDS: Keywords: torpedo defense; detection; multiple targets; localization; acoustic sensors; sonar

N101-063 TITLE: Robust Rotary Union for High Speed, High Power Density Rotating Electrical Machines

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 320, Electric Ship Office

OBJECTIVE: Develop and demonstrate robust rotary union designs suitable for shipboard application to high speed, high power density rotating machines being developed by the Navy for Next Generation Integrated Power Systems (NGIPS).

DESCRIPTION: Increased shipboard electrical power requirements, needed to enable future weapon systems and electric drive propulsion systems, necessitate improvements to component power densities. Improved component power densities maximize installed power, and accommodate the necessary power conversion equipment within ship machinery arrangement constraints (ref 1).

For rotating electrical machines, including prime power generators, significant power density improvements are achievable through high speed operation and liquid cooling of the generator rotor (ref 2). High speed operation enables direct coupling to prime movers (engines) and elimination of the otherwise necessary reduction gearbox. Liquid cooling of generator rotors enables increased flux densities through more effective thermal management of rotor electrical losses. Alternately, high-temperature super conducting generators and motors enable significant increases in power density by virtually eliminating rotor losses (ref 3). Both high-speed, liquid-cooled generators and high-temperature superconducting generators require rotating couplings (i.e. rotary unions) to transfer the rotor cooling medium from the stationary equipment skid to the rotating shaft. Current commercial rotary unions do not meet the combinations of flow capability, speed capability, durability and reliability required by critical naval systems.

This topic seeks to explore innovative, affordable, advanced concepts and technologies to develop robust high speed rotary union designs suitable for application in advanced liquid cooled and high temperature superconducting generators. The technical challenges are providing a rotary union that operates satisfactorily in a high speed generator application at the flows and pressures required, specifically: zero or minimal leakages through seals, dynamically stable-with no modes excited by a dynamically active generator rotor, long life/durability (i.e. 12,000 hour time between overhaul or repair), reliability (i.e. 3000 hours mean time between failure), and graceful degradation (i.e. failure modes are not catastrophic and do not preclude generator from operating at reduced capability). Proposed concepts should be able to withstand severe shipboard environments (vibration, shock, and duty cycle).

PHASE I: Demonstrate the feasibility of innovative, affordable, advanced concepts and technologies that will result in the development of robust high-speed rotary union design(s) suitable for application in advanced liquid-cooled and high-temperature superconducting generators. Develop an initial conceptual design and establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete product development milestones for verifying performance and suitability.

PHASE II: Develop and demonstrate the prototype(s) as identified in Phase I. Through laboratory testing, demonstrate and validate the performance goals as established in Phase I. The prototype must meet Navy Shock and Vibration requirements (refs 4-5). Refine and demonstrate the capabilities of the system. Conduct life cycle and environmental testing. Develop a cost benefit analysis and a Phase III testing, qualification and validation plan.

PHASE III: The small business will work with the Navy and commercial industry to transition a full-scale system into advanced naval power systems demonstrations and tactical design development programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Rotary unions are featured in several commercial applications including machine tools, mills, crude oil processing, and chemical industry. Advances in rotary union designs for naval applications will provide enhanced capability directly applicable to commercial applications, resulting in improved performance, higher reliability, increased durability, and graceful degradation.

REFERENCES:
1. Doerry, Norbert "Next Generation Integrated Power System (NGIPS) Technology Development Roadmap", Naval Sea Systems Command, Ser 05D/349, 30 Nov 2007.

2. Ray M. Calfo, Matt B. Smith, John E. Tessaro, "High-Speed Generators for Power-Dense, Medium-Power, Gas Turbine Generator Sets", Naval Engineers Journal, Volume 119, Issue 2, October 2007, Pages: 63-81.

3. Stephen D. Umans, "Transient Performance of a High-Temperature-Superconducting Generator", 2009 International Electric Machines and Drives Conference, Miami, Florida, May 3-6, 2009.

4. Doerry, Norbert, "Next Generation Integrated Power System (NGIPS) Technology Development for the Future Fleet", IEEE Electric Ship Technologies Symposium Baltimore, MD, April 21, 2009, http://ewh.ieee.org/conf/ests09/ESTS-2009%20Capt%20Doerry.pdf

5. MIL-S-901D, Military Specification Shock Tests H.I (High-Impact) Shipboard Machinery, Equipment, And Systems, Requirements, http://www.dcfp.navy.mil/library/dcpubs/MIL-S-901D.pdf

6. Additional information from TPOC on Rotary Union Technical Requirements.

KEYWORDS: high-temperature super conducting; water-cooled generator; power density; electric ship; electric drive; NGIPS; rotary coupling

N101-064 TITLE: Innovative Predictive Tools for Successful Processing of Propylene Glycol Dinitrate for Production of Otto Fuel II

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Mark 48 ACAP Torpedo (PMS404), ACAT III

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: To develop innovative predictive tools that would allow production plant personnel to quickly evaluate materials in the production plant for Otto Fuel II. This process will provide will provide a safer method for personnel conducting the proposed methods and afford a reliable, scientific based output for evaluation by personnel that will indicate whether the starting materials will process effectively. This method will eliminate wasted resources involved with the evaluation of starting raw materials in the production of Otto Fuel II.

DESCRIPTION: Propylene glycol dinitrate (PGDN) is used in the manufacture of Otto Fuel II. The PGDN manufacturing process involves the continuous nitration of propylene glycol using a mixed acid. If either starting material is contaminated with small quantities of impurities, it leads to major safety and quality issues with the product PGDN and subsequent Otto Fuel II production. The quality control of the starting materials (propylene glycol and mixed acid) is currently evaluated by non-ideal methods. A new innovative approach is required that will insure quality product and robust processing in the manufacturing plant.

PHASE I: Phase I will include the development and small-scale demonstration of the proposed predictive tool for evaluation of the propylene glycol and mixed acid starting materials. This method will be compared with the existing methods. Proof of concept will be completed upon successful demonstration of the science behind the developed tools.

PHASE II: Phase II will include further development and refinement of the predictive tool(s). This will include the development and delivery of a prototype system that will be used by the production plant to nitrate various lots of propylene glycol using various lots of mixed acid. This prototype turn-key system will include technical guidance in the form of a technical report with detailed operating instructions for any proposed equipment. The technical report will also include a detailed description of the proposed science behind the researched approach.

PHASE III: Phase III will provide a production system for transition to the Otto Fuel II (nitration) manufacturing plant. All changes requested as a result of the Phase II development will be included. A comprehensible operations manual will be provided that describes the equipment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Various processes in industry take advantage of similar continuous nitration processing like the manufacture of PGDN. These processes also rely on predictive tools to determined if starting materials will process well in the respective manufacturing process. The predictive tools developed could easily be adapted to industrial processes. The process can be used for pharmaceutical grade nitroglycerin manufacturing industry as well as the manufacture of various nitrate esters that are currently used in the propulsion and explosive components of a number of DOD weapon systems.

REFERENCES:
1. Fraser, R. T. M. Stability of nitrate esters. Chemistry & Industry (London, United Kingdom) (1968), (33), 1117-18. CODEN: CHINAG ISSN:0009-3068. CAN 69:78867 AN 1968:478867

2. Storm, C. G. Potassium-Iodide-Starch Paper. Journal of Industrial and Engineering Chemistry (Washington, D. C.) (1910), 1 802. CODEN: JIECAD ISSN:0095-9014

KEYWORDS: nitration; propylene; glycol; Otto Fuel II; trial; nitrate ester

N101-065 TITLE: Novel Composite Submarine Hatch Materials and Construction Methods

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PMS399 SOF Undersea Mobility Programs - ASDS and DDS

OBJECTIVE: Develop composite watertight materials and fabrication methods that can be used in submarine and submersible hatches capable of withstanding pressures of up to 1,000 PSI (threshold) and 1,100 PSI (objective).

DESCRIPTION: U.S. Naval submarines and submersibles require watertight hatches that are capable of withstanding significant pressures without leaking or failing. The standard steel hatch design has complex linkages, handwheel assemblies, locking rings, etc. that secure the hatch, but are not intended to be exposed to seawater. This hatch design is adequate for standard submarine operations, but is inadequate for many submersible operations, such as locking divers in and out of the submersible. In many cases, the internal components of the hatch are subjected to continual immersion in seawater. This has led to a maintenance issue due to significantly higher corrosion rates and seawater washout of lubricants. A novel composite hatch material and fabrication method is sought that would allow a composite hatch assembly to be capable of withstanding significant pressures on either side of the hatch without leaking, while simultaneously increasing the corrosion resistance and decreasing the weight of these hatches.

PHASE I: Perform basic R&D to determine the most likely candidate materials and fabrication methods that can be used to construct composite hatches capable of withstanding pressures on either side of the hatch without leaking or failing. Actual submergence pressures vary greatly. For this SBIR effort (as a proof of concept only), the composite materials must be able to resist pressure differentials up to 1,000 PSI (threshold) and 1,100 PSI (objective). Demonstration of the ability of the materials and fabrication methods proposed to withstand higher pressures will be considered an additional benefit, but is not required during this SBIR effort. Demonstrate by engineering analysis that the materials and design concepts are scalable to a full-scale submarine hatch design.

PHASE II: Conduct proof-of-concept testing in a laboratory environment of the most likely candidate materials and fabrication methods evaluated in Phase I. Implement and verify the design and concepts from Phase I in full-size prototype hatch designs. Demonstrate in a laboratory environment the ability of a scale model hatch designed and built using these materials and methods to effectively create a watertight seal and withstand these pressures without leaking. Determine through testing the fire resistance, impact resistance and pressure resistance of this new composite material. Perform full-scale laboratory testing, including long term pressure cycle testing, UV and fire resistance testing to assess the ability of a full-scale hatch fabricated from these materials and methods to resist damage from exposure to the environment. Develop one final Engineering Development Model (EDM) hatch 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 website www.sba.gov provides guidance, examples, and contact information for assistance.

PHASE III: Conduct shipboard testing and suitability analysis of the EDM system, including shock and vibration testing. Validate safety and watertight integrity 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: This technology would have applicability to any industry where the requirement to form a watertight (or airtight) pressure boundary exists, and where weight is also a critical concern. This includes the commercial submersible industry, as well as the airline and space industries.

REFERENCES: (Note to offerors: References are provided for general information and not to suggest approaches. Offerors are expected have among the proposed personnel (which, in addition to the small business could include consultants and/or subcontractors) the knowledge and experience necessary to tackle the task.)

1. NASA Tech Briefs. Submarine Design Certified on FEA and Sensor Testing. April, 2006.
http://findarticles.com/p/articles/mi_qa3957/is_200604/ai_n17179574/

2. Atlantis 1. Submersible Structure. http://web.mit.edu/12.000/www/m2005/a1/Robotics/substruc.htm

3. Tanguy Messager, Mariusz Pyrz, Bernard Gineste, and Pierre Chauchot. "Optimal laminations of thin underwater composite cylindrical vessels," Composite Structures, Volume 58, Issue 4, December 2002, Pages 529-537.
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TWP-472841H-8&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1015378538&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=3d89fc4f305db931ee32b501614ffd15

4. Tanguy Messager, Pierre Chauchot, and Benoit Bigourdan. "Optimal design of stiffened composite underwater hulls," III European Conference on Computational Mechanics Solids, Structures and Coupled Problems in Engineering, 2006. http://www.springerlink.com/content/k53738j521645451/

5. Osse, T.J., Lee, T.J., “Composite Pressure Hulls for Autonomous Underwater Vehicles”, Proceedings of OCEANS 2007 Publication Date: Sept. 29 2007-Oct. 4 2007.
http://ieeexplore.ieee.org/xpl/RecentCon.jsp?punumber=4446228

KEYWORDS: composites; hatches; submersibles; pressure; submarines; corrosion

N101-066 TITLE: <u>Hull Contamination Measurement</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: VIRGINIA Block 4

OBJECTIVE: This topic seeks to identify and demonstrate a surface contaminant measurement technique that can be adapted to a ship construction environment.

DESCRIPTION: The current state-of-the-art of submarine hull surface contamination measurement is limited to a test for one known contaminant known as amine bloom. This test consists of 3 chemical swatches, about 2 cm^2 each, applied over an area of hull about 10 m^2, resulting in an area sampling of a less than a mere 0.01% of the entire ship's hull for only one contaminant. To further exasperate matters, this amine bloom test has been know to give false negative results, i.e. giving results of no amine bloom when amine bloom is actually present on the hull. There are no tests for other contaminants like vacuum-pump oil or silicone.

A high speed, accurate method of checking for surface contaminants, like lubricants and amines, would allow focused treatment of areas and allow better use of paints and coatings. A surface contamination measurement method should be adaptable for use in an industrial environment of the shipyard, be able to cover large areas in excess of 30,000 square feet, yield accurate results and provide precise location of the contaminants for targeted cleaning.

The proposed hull contamination measurement system must possess the following attributes:

1. Indicate the presence of the following contaminants:

1.1. Amine
1.2. Vacuum Pump Oil
1.3. Silicone

2. Accuracy:
2.1. 100% detection of contaminant areas of 100 cm^2 or greater
2.2. At least 50% detection of contaminant areas between 2 cm^2 and 99.9 cm^2

3. Sampling area:
3.1. At least 1 m^2 for hull diameter of 10 m or more
3.2. At least 0.5 m^2 for hull diameter from 4 m to 9.99 m
3.3. At least 0.1 m^2 for hull diameter from 1 m to 3.99 m

4. Area Coverage Rate:
4.1. No more than 15 seconds for 1 m^2 for hull diameter of 10 m or more
4.2. No more than 15 seconds for 0.5 m^2 for hull diameter from 4 m to 9.99 m
4.3. No more than 15 seconds for 0.1 m^2 for hull diameter from 1 m to 3.99 m

5. Manning:
5.1. Require no more than 2 people to operate

6. Operation:
6.1. Hand-held display indicating contaminant
6.2. Indication of contaminant type
6.3. Locate contaminant within sampled area to within 5 cm

7. Weight Restriction:
7.1. Less than 5 kg for hand held sensor
7.2. Less than 50 kg for remote processing or powering equipment

8. Size Restriction
8.1. Less than 0.01 m^3 for hand held sensor
8.2. Less than 2 m^3 for remote processing or powering equipment

9. Shock
9.1. Hand held sensor survive 2 m drop without damage
9.2. Remote processing and powering equipment survive 20 Joule impact without damage

PHASE I: Conduct feasibility study on the methods to indicate the surface presence of amines, vacuum pump oils, and silicone. Make recommendation on method to pursue in Phase II.

Exit Criteria:
1. Identify physical processes that could be used to develop a non-contacting test device.
2. Survey industry and identify the potential suppliers of the components to construct the test device.

PHASE II: Fabricate a prototype test device based on the study of Phase I. Demonstrate the performance capabilities of the prototype to locate contaminants in a controlled laboratory environment.

Exit Criterion:
1. Indicate presence of contaminants 10 cm^2 on flat surface.

PHASE III: Develop industrialized prototype and demonstrate in the shipyard environment.

Exit Criterion:
1. Demonstrate that the 9 requirements under Description are satisfied.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The contaminant detector has broad applications to areas of manufacture that have difficulty maintaining the clean environment required to apply paints and coatings.

REFERENCES:

1. Burton, Bruce L., “Amine –Blushing Problems? No Sweat!”, The Society of Plastics Industry Fall 2001 Epoxy Resin Formulator’s Meeting.

2. Elcometer 139 ABC Amine Blush Check Kit Operating Instructions, Doc No. TMA-0294, Issue 01, Text with Cover No. 18718, 2006, Elcometer Instruments Ltd.

3. O’Malley, C.L., J Simser, and C.M. Pravlik, “An Ounce of Prevention … The reliability of Field Methods for Detecting the Presence of Amine Blush on Epoxy Coatings,” PACE 2005 Conference.

KEYWORDS: Surface Contaminants; Adhesion

N101-067 TITLE: Material Multi-Solution for Hypersonic Systems

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: IWS 3C, ONR Electromagnetic Railgun, MDA, Gun Launch Projectiles

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OBJECTIVE: Development of a novel, light-weight material for use within a hypersonic weapon system. The material must interface with system structural components and meet all engineering specifications for mission completion.

DESCRIPTION: Incorporating composites and other advanced materials into a hypersonic system can offer innovative solutions to engineering requirements while also providing a weight-benefit in a system’s overall design. Boron-aluminum with a unidirectional layup was used in space shuttle tubular struts, resulting in a 44 percent weight savings as compared to alternative material solutions. The National Aero-Space Plane (NASP) program employed the use of refractory composites and metal matrix composites to fulfill the X-30 airframe’s high temperature and high strength requirements. Carbon-carbon is widely used for its thermal management properties, specifically for the Air Force development of skin panels for air-breathing hypersonic vehicles.

As part of a hypersonic system, material solutions must be capable of fulfilling design requirements and surviving adverse mission environments. The proposed solution will consider a hypersonic launch environment at a minimum 45 k-Gee acceleration, and load thresholds of 450 ksi and 250 ksi in compression and tension, respectively. To maintain a weight benefit in an overall system design, it is expected the material density must be no greater than 0.125 lb/in^3. The fabrication process must also be capable of producing non-cylindrical geometries. The material must be capable of interfacing with system components made of other materials; for example, a steel ogive section of a missile airframe may interface with a composite aft-end at the tail section. The material must not exhibit elongation greater than 1%. It is expected that a hypersonic system will perform at super-elevated temperatures; therefore, a proposed solution may include exterior coatings for thermal management.

The Navy intends to promote exploration into advanced materials as an enabling technology for Navy guided munitions. It is also the intent to develop technologies as innovative design solutions for multiple hypersonic weapon systems. Incorporating composites or other advanced materials introduces the potential for a more robust solution to challenging design constraints, with the added benefit of a component weight reduction. It is recommended that a literature review be performed to assess the current state of the art (SOTA) composite materials development and fabrication techniques and their potential to interface with a hypersonic weapon system.

PHASE I: Based on an assessment of current SOTA composite materials development and fabrication techniques and their potential to integrate into a hypersonic weapon system, perform material characterization and concept development to meet the criteria defined in the description. The contractor will be expected to provide a feasibility report explaining the proposed concept and how it provides an innovative solution which fulfills all specified design requirements.

PHASE II: Implement strategies proposed in Phase I. Produce material for interface with full or partial-scale hypersonic system models. Systems will be tested in a hypersonic test facility for system demonstration of concept. Develop Modeling and Simulation (M&S) methodologies to capture material interface within a hypersonic system. Utilize M&S to understand material performance under mission requirements and environment.

PHASE III: Pending successful proof of concept and M&S validation, Phase III will focus on support of systems of interest. It is intended that Phase III will be supported by multiple agencies/programs for specific mission requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: NASA, private aeronautical and space industry, materials development and processing industry.

REFERENCES:

1. Weisinger, MD, and Forest, JD, Miller, M, "Feasibility Demonstration Program for the Application of Boron/Aluminum to Space Shuttle," CASD-NAS-74-017, General Dynamics Corporation Convair Division, May 1974.

2. Barthelemy, R., "Recent Progress in the National Aerospace Plane Program," IEEE AES Magazine, pp. 3-12, May 1989.

3. Blevins, R. and Holehouse, I., "Thermoacoustic Loads and Fatigue of Hypersonic Vehicle Skin Panels," Journal of Aircraft, vol. 30, no. 7, pp. 971-974, Nov-Dec 1993.

KEYWORDS: advanced materials; composites; hypersonic; modeling & simulation; materials processing; projectiles

N101-068 TITLE: <u>Technologies for Reduced Source Level Sonar Systems</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS-415: Anti-Torpedo Torpedo Defense System (ATTDS): ACAT II, PMS401BQQ-10

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OBJECTIVE: The objective of this work is to identify technologies and system concepts that will provide effective active sonar performance with significantly reduced transmitter source level.

DESCRIPTION: Navy surface and submarine combatants rely primarily on high source level (transmitter power) active sonar for undersea target detection and localization. In state-of-the-art systems such as the SQS-53C, high source level is required to attain the required detection ranges while using a relatively noisy bow-mounted receive array, which is operationally convenient. Performance in state-of-the-art systems has been governed by waveform parameter selections, signal coherence, receiver array size and self-noise. Key design trade-offs are discussed in the references. The current operational concept has been problematic for several reasons: transmitter power drives system acquisition cost, maintenance cost, and system failure rate; waveform and duty cycle restrictions limit detection performance against very slow (low Doppler) targets. Recent environmental rulings have limited the Navy's latitude to employ these systems for training in preferred operating areas.

The Navy is seeking innovative technology, beyond the state-of-the-art to address current limitations while improving sonar detection performance in operationally relevant environments. Detection performance improvement of 4-6 dB is sought to justify back fit of legacy systems. Offerors may propose innovative system concepts including source arrays, receive arrays, deployed sensor concepts, new operating frequencies, waveform innovations, spectral and spatial processing, or any combination of these elements (see refererences for recent relevant research). The Navy is interested in concepts that involve a degree of technical risk. The proposed concept should have the potential to be low cost and have relatively low installation impact; however, ideas may range from current technology, near term system solutions to more radical technologies for next generation systems. Well-conceived responses may define the framework for a new active sonar operating paradigm.

PHASE I: The contractor will describe in detail the proposed system concept and associated technologies. Phase I analysis will make the case for feasibility of the proposed concepts. Supporting calculations and preliminary high level design should be included.

PHASE II: Phase II will focus on the development of a prototype of key system components for evaluation. A cost benefit study will be conducted to estimate the life cycle cost vs. system effectiveness as compared to conventional surface ship sonars.

PHASE III: Phase III will consist of full scale testing of the proposed innovative system concept in a battlespace environment. The offeror will be expected to identify candidate systems for transition and make the case for implementation or evaluation by the acquisition program manager or prime contractor.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This topic could produce technologies relevant to commercial senor applications including seismic exploration, medical imaging, and automotive motion/position sensors. The technology could be expected to provide reduced system cost, improved reliability, improved performance and reduced environmental impact.

REFERENCES:
1. H.L. Van Trees. Optimum Array Processing. John Wiley & Sons. New York, 2002.

2. J.A. Szelag and T.R. Howarth, "Investigation of single crystals for U.S. Navy standard electro-acoustic transducer applications", J. Acoust. Soc. Am. 125 (2009)

3. Calvo, D.C.; Gaumond, C.F.; Fromm, D.M.; Menis, R.; Lingevitch, J.F.; Edelmann, G.F.; Kim, E.; "Detection enhancement using multiple time-reversed guide sources in shallow water", Proc. IEEE OCEANS, Sept. 2005.

4. Biddiscombe, J.A., Kingsley, S.P., "An investigation into the principles of signal detection using multiple simultaneous waveforms" IEE Colloquium Advanced Transmission Waveforms, June 1995.

KEYWORDS: Keywords: torpedo defense; sonar; active; signal processing; array processing; undersea warfare

N101-069 TITLE: <u>Innovative Wideband Antenna Technology for Ultimate Consolidated Submarine Mast</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS450: VIRGINIA Class submarine: ACAT I

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: To develop wideband antenna design and efficient wideband electronics as a step toward the long-range goal of the development of consolidated, multifunction submarine masts. Specifically, the objective is to investigate innovations in wideband antenna design and efficient wideband.

DESCRIPTION: In the long-term, the Navy is moving toward a multifunction submarine mast (or family of masts) supporting communications, electronic warfare (EW), and radar functions This topic, with its focus on innovative wideband antenna development, provides a key step in developing the technologies necessary for multifunction submarine masts. The Navy is faced with the challenge of supporting the communications, EW, and radar functionality required on submarines by using masts deployed from the submarine sail. The limited volume available in the sail limits the size and number of submarine masts, therefore limiting the volume available to provide the desired capabilities. Capability requirements in the areas of comms, EW, and radar continue to increase; however, supporting new functions or enhanced performance often requires additional antenna volume that is unavailable with the current submarine sail architecture. By developing a single mast that consolidates multiple functions in an efficient manner, new capabilities and improved performance could be achieved without requiring significant modifications to the sail or submarine platform. Also, by using a family of common masts in the submarine sail (to provide the full complement of capability and redundancy), a common design approach could be used for other mast system elements (such as mast deployment, signal distribution, dip loops, and hull penetrators), greatly reducing life cycle costs.

This SBIR topic focuses on one of the key enabling technologies to achieve the vision of a common mast is wideband antennas. Currently, antennas such as spirals and bicones are used to provide wideband functionality. Although these antennas are effective, there are limits to the level of performance that can be achieved in a given volume. In the future, there may be a need to expand the spectrum of frequencies supported by submarines, which will further stress the capabilities of legacy antennas. This topic solicits innovative antenna approaches that can achieve very high bandwidths (10:1 or higher) while minimizing the overall footprint of the antenna. New technology areas of consideration may include (but are not limited to) fractal antennas, metamaterial antennas, or reconfigurable antennas. Candidate antennas should target a cylindrical volume no greater than 18" in diameter by 36" in height. Antennas that are within a 7" diameter and roughly 12" in length are also of interest. The ability to provide 360° coverage is also desired.

For a wideband antenna to effectively support multiple functions, associated wideband electronics (such as filters, channelizers, and amplifiers) may also be required. Innovations in these areas are also of interest, but should be confined to applications that directly couple the electronics with innovative wideband antennas.

PHASE I: Perform a study identifying innovative wideband antenna designs that could support multiple radio frequency functions in a minimal volume. Key features include antenna bandwidth, gain, 360° coverage, and size/form factor. Performance variations as a function of frequency and size must be characterized. Analysis shall also include development of notional concepts for implementing the antenna as part of a consolidated multifunction submarine mast.

PHASE II: Develop a prototype antenna (or set of antennas) that can be tested in a laboratory environment. Prototype antenna(s) shall demonstrate enhanced performance relative to volume, particularly in the areas of gain, bandwidth, and antenna pattern.

PHASE III: Develop a full scale prototype antenna system that can be integrated with a notional submarine mast and tested in a relevant environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS:
A wideband multifunction antenna system has strong potential application to both commercial and other DoD areas. Potential commercial applications could include wireless networking, broadband RF links, or antenna consolidation on ships and aircraft. Other military applications include surface ships, aircraft, and unattended sensors.

REFERENCES:
1. Robert Ackerman, “Joint Forces Redo Warfighting Doctrine,” Signal, June 2008, 62, 10.

2. “Royal Netherlands Navy Selects Thales's Integrated Mast,” Thales Nederland; issued Dec. 20, 2007 (Search Thales Integrated Mast at http://www.thalesgroup.com)

3. J.D. Kraus, Antennas, McGraw-Hill, 1988.

4. D. Hambling, "5 Metamaterials That Make Matter Invisible, Silent or Blindingly Fast", Popular Mechanics, September 2009, http://www.popularmechanics.com/technology/industry/4328772.html

KEYWORDS: Keywords: Antennas, Wideband, Submarine Systems, Radio Frequency (RF), Electromagnetics

N101-070 TITLE: <u>Energy Storage For Facilities Renewable Energy</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Energy Savings Performance Certification Program ACAT IV

OBJECTIVE: Develop a cost effective energy storage system to integrate with renewable energy systems to provide energy when renewable resource is not available and also to allow greater than 25% renewable energy to provide power to the grid. Energy storage must also improve on current recharge rates. Energy storage system must be capable of maintaining rated power for 24 hours with energy densities of no less than 150Wh/Liter.

DESCRIPTION: In order for renewable energy to be used widely in the Navy as-well-as the rest of the U.S. energy storage must be a part of the system to 1. provide energy when the renewable resource is not available, i.e., the sun is not shining and the wind is not blowing and 2. to eliminate the inherent instability of renewable power due to constantly changing power levels from the sun and wind. Currently existing energy storage devices are too large, too expensive and require too long to recharge to be viable and cost effective.

The Navy has evaluated many technologies which may be suitable as part of an energy storage solution. The forms currently of particular interest are: electro-chemical (e.g., fuel cells and batteries), electro-static (e.g., capacitors and super capacitors), thermal (e.g., thermal piles), and kinetic (e.g., flywheels). However, today’s energy storage devices do not yet have the energy density, operational flexibility or shelf life necessary for renewable energy application. As a result, the Navy is not able to capitalize on the latest energy efficiency technologies which require the ability to seamlessly provide uninterrupted power at all times. The development of a renewable energy energy storage system would be a significant enabler the wide spread use of renewable energy throughout the Navy.

This topic seeks innovative approaches to the development of an advanced energy storage system. Proposed energy storage system concepts should meet the following thresholds:

- Energy Storage 150Wh/Liter.
- Power Density 2000W/Liter.
- 6000 full discharge /charge cycles while maintaining 80% of initial performance.
- 5 year shelf life, capable of sustained storage.

- Operation at temperatures as high as 150F.
- Maintain rated power for 24 hours.

PHASE I: Determine the feasibility of developing an energy storage system capable of being incorporated into a renewable energy system that meets the above thresholds. Evaluate attributes of the system, including energy density, power density, size, transient dynamics, shelf life, and anticipated maintenance requirements, using detailed models or small subscale components. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Finalize the design concept from Phase I and fabricate a diagnostic test bed prototype for a 500kW-level demonstrator. Validate prototype capabilities using laboratory testing and provide results. Demonstrate proposed installation, maintenance, repair, and regeneration methodologies. Develop a cost/benefit analysis and perform testing and validation.

PHASE III: Manufacture and market commercial energy storage device developed in Phase II. Develop the commercial potential of the technology for making it available as a candidate for inclusion in the Navy's Energy Savings Performance Certification (ESPC) Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Improved energy storage device will be marketed commercially to increase energy supplied to the grid by renewable energy.

REFERENCES:
1. Sandia National Laboratories ESS Publications: http://www.sandia.gov/ess/Publications/pubslist.doc

2. Bottling Electricity: Storage as a Strategic Tool for Managing Variability and Capacity Concerns in the Modern Grid: http://www.sandia.gov/ess/About/docs/BottlingElectricity.pdf

3. Study Plan for Critical Renewable Energy Storage Technology (CREST): http://www1.eere.energy.gov/solar/pdfs/crest_study_requirements.pdf

4. An Assessment of Battery and Hydrogen Energy Storage Systems Integrated with Wind Energy Resources in California"; http://www.energy.ca.gov/2005publications/CEC-500-2005-136/CEC-500-2005-136

KEYWORDS: Renewable energy; Energy storage; Photovoltaic; Wind energy

N101-071 TITLE: <u>Advanced Shore Based Mooring (ASBM)</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: NAVFAC Facilities Improvement Program ACAT IV

OBJECTIVE: The objective is to develop an efficient shore-based mechanical system for reliably mooring US Navy ships to the Navy's piers and wharves. "Efficient" means that the mooring holds the ship in surge, sway and yaw, but leaves the ship full unrestrained in heave, roll and pitch. "Shore-based" means that no equipment is stored on the ship or boat. "Mechanical" means that a minimum of personnel (and possibly no shore personnel) are required to make up the mooring. "Reliable" means demonstration that the shore-based mooring system will hold ships in environmental conditions at least as well as current mooring practice. "US Navy ships" means all large cargo, combat and submarine ships and boats that are currently operating in the US Navy Fleet, except maybe the aircraft carrier class of ships (CV).

DESCRIPTION: The basic process for mooring a ship has remained unchanged since the first ships were sailed thousands of years ago. Many mooring hardware failures result from mooring line working inefficiently and resulting in the mooring trying to lift up or pull down the ship as water-level changes. Ship cleats/bits, dock bollards, mooring lines and other mooring hardware are not designed for these ship weight loads, nor are the structures that anchor this mooring hardware. Giving these inefficiencies, fender placement, performance, and maintenance is always problematic.

PHASE I: Develop a conceptual design for an efficient advanced shore-based mooring (ASBM) system for reliably mooring US Navy ships to the Navy's piers and wharves. There should be a particular focus on the US Navy's unique classes of ships and boats that are unlike normal flat sided commercial cargo carriers, including planned classes of surface ships with sharp radar-defeating angled sides and classes of submarine boats with soft surfaces and many hull appurtenances. US aircraft carriers that currently require camels to keep the overhanging deck clear of the wharf and pier need not be included.

PHASE II: Develop a detailed design and build a rough prototype of the chosen ASBM. Both grip- or vacuum-based attachment to the hull is acceptable. The prototype must work for a large range of ship/boat classes and sizes. The ASBM prototype must be amenable to full automation from the bridge of the ship or from a port control center. Different ASBM prototypes may be specified for surface ships and compared to subsurface boats.

PHASE III: Install and test the prototype an ASBM at a US naval installation. Assess the basic reliability and efficiency of the ASBM prototype. Suggest specific detailed design changes to make production models work better.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Shipping companies are already seriously considering how to improve the non-optimized nature, the large cost, and labor-intensive process of line-based mooring that is currently used in most ports throughout the world. The Navy's unique requirements will not necessarily be met by these commercial systems, although the basic mechanics between commercial and navy systems may be identical.

REFERENCES:
1. UFC 4-159-03, United Facilities Criteria, Design: Moorings, Naval Facilities Command, October 2005

2. S9086-TW-STM-010/CH-582R2, Naval Ships' Technical Manual, Chapter 582, Mooring and Towing, Naval Sea Command, December 2001

KEYWORDS: Pier; Wharf; Ship; Mooring; Berthing; Automated; Fender

N101-072 TITLE: Non-Plastic Biodegradable Waste Bag

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a replacement for standard plastic garbage bags aboard ship. The alternative must meet marine biodegradable and compostable ASTM standards and be able to be processed through Navy waste processing equipment in a manner similar to food, paper, and other organic waste. In addition, the material must not be considered plastic under the International Maritime Organization (IMO) definition of plastic and must be non-toxic to the marine environment per requirements in the ASTM biodegradable testing. This initiative will support requirements in EO 13423 (Strengthening Federal Environmental Energy, and Transportation Management, the Farm Security and Rural Investment Act and the Resource Conservation and Recovery Act. Also, other government organizations, such as, the California Lt. Governor's Office and National Oceanic Atmosphere and Administration (NOAA) have expressed interest to the Navy in marine biodegradable materials.

DESCRIPTION: The Navy currently uses a combination of plastic and paper bags for collection of solid waste. The Navy must comply with MARPOL Annex V requirements which prohibit plastic disposal at sea. Therefore, despite having desired properties, plastic waste bags result in an increased plastic waste stream afloat. Plastic continues to pose the greatest challenge and labor requirements for solid waste management afloat. Plastic negatively impacts the fleet through increased labor, storage, and offload requirements. NAVICP's November 2008 USS Porter underway study reported that plastic bags accounted for 32 percent of the overall plastic waste stream. Using existing paper bags in place of plastic is an alternative; however their use is limited due to inferior water barrier and strength properties.

Development of a high strength, lightweight, water-proof, marine biodegradable, and non-plastic waste disposal bag will assist the fleet in reducing their at-sea plastic usage and significantly decrease the volume of plastic waste that must be processed and stored aboard. The use of plastic packaging continues to rise in commercial markets and few materials are available to meet plastic reduction initiatives afloat.

In order for the new waste bag to be successful, it must meet several basic criteria:
• Must be water resistant since food scraps have high moisture content
• Must show and meet biodegradability per ASTM D7081 and ASTM D6400
• Must be composed of a biobased material
• Must be non-toxic to the marine environment
• Must be capable of being processed though the existing shipboard equipment (i.e. Pulper and shredder)
• Must be of sufficient strength to resist tearing or bursting when filled with liquid waste.

This is a challenging R&D effort for two primary reasons. Currently, biodegradable waste bags in the marketplace are composed primarily of a biobased material called, Polylactic Acid (PLA). First, this material falls under the IMO definition of plastic and cannot be disposed of in the marine environment. Secondly, few available materials readily biodegrade in the marine environment. PLA often passes the compostable plastic ASTM biodegradation testing but does not meet the ASTM Marine biodegradation standard. The Navy has tested Polyhydroxyalkanoates (PHA), another biobased plastic that successfully passes ASTM D7081, but also falls under the current IMO definition of plastic.

PHASE I: Investigate materials and manufacturing processes to identify and produce a material that can be successfully transformed into a waste bag. The material must be developed to meet desirable characteristics including water resistance, strength, non-toxic and marine/compost biodegradable.

PHASE II: Develop prototype bags and complete performance testing, shipboard equipment testing, and begin to identify producers that will be able to manufacture the bags in sufficient quantities for Navy needs. The Navy will perform or arrange for shipboard testing to evaluate Sailor responses to the new material as appropriate.

PHASE III: Develop a manufacturing plan and identify expected Navy usage. Work with GSA and DLA to incorporate the bag into government procurement systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The new bag will possess many environmentally advantageous characteristics over conventional plastic bags. This will provide a new product that is not currently available in the commercial marketplace and may lead to development of other materials. The new bags will biodegrade under composting and marine environment standards. The navy has not identified biodegradable plastic bags on the marketplace that have successfully passed ASTM D7081.

REFERENCES:
1. IMO Definition of Plastic: Plastic means a solid material which contains as an essential ingredient one or more synthetic organic high polymers and which is formed (shaped) during either manufacture of the polymer or the fabrication into a finished product by heat and/ or pressure. Plastics have material properties ranging from hard and brittle to soft and elastic. Plastics are used for a variety of marine purposes including, but not limited to, packaging (vapor-proof barriers, bottles, containers, liners), ship construction (fiberglass and laminated structures, siding, piping, insulation, flooring, carpets, fabrics, paints, and finishes, adhesives, electrical and electronic components), disposable eating utensils and cups, bags, sheeting, floats, fishing nets, strapping bands, rope and line.

2. ASTM Standard Specifications (available at http://www.astm.org/Standard/index.shtml)

3. ASTM D 7081 - 05: Standard Specification for Non-Floating Biodegradable Plastics in the Marine Environment

4. ASTM D 6400 - 04: Standard Specification for Compostable Plastics

5. Bag, Waste Receptacle, Paper,GS-15F-L0011, 2 pages.

KEYWORDS: Biodegradable; waste processing; green procurement; biobased; materials; non-plastic

N101-073 TITLE: Terminal Guidance for Autonomous Aerial Refueling

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: Advanced Development Program Office NAVAIR, 4.12.7, Non-ACAT

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop technologies to support the terminal guidance of unmanned aircraft during autonomous aerial refueling (AAR).

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 Operating Manual.

DESCRIPTION: Tankers significantly extend the range and duration of combat sorties for current tactical Navy aircraft such as the F/A-18, and will play an important role for future unmanned aircraft. While differential GPS and other technologies are capable of guiding aircraft to a position proximate to the tanker, these technologies are not well-suited for terminal guidance of the aircraft probe into the tanker's drogue during autonomous aerial refueling (AAR). What is needed is a terminal guidance technology capable of providing accurate relative orientation measurement between the refueling probe on the aircraft and the drogue. In order to maintain stealth under normal flight, the technology must be deployed only during refueling, yet must not interfere with the functionality of the refueling system in any way.

PHASE I: Develop a detailed architectural design of a terminal guidance system that can be used during autonomous aerial refueling. Analyze the integration of necessary components. Model the expected performance and identify the methods to measure actual performance. Provide a baseline for the development of prototype hardware.

PHASE II: Demonstrate the technology with a prototype system in a laboratory setting. Measure the performance of the system and compare this performance to expected results. Address realistic factors such as relative motion between the probe and drogue and emulate these factors in experimental demonstrations.

PHASE III: Complete the development of the technology by performing full scale tests with aircraft components in a relevant environment. Transition the technology to the appropriate Navy programs for further development and acquisition.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology could be used for refueling ships at sea or recovering scientific buoys, practice torpedoes, and unmanned surface and underwater vehicle. Trucks and rail cars could be modified to aid in positioning these vehicles safely and reliably.

REFERENCES:

1. MIL-A-19736A, Military Specification for Aerial Refueling Systems

2. Autonomous Aerial Refueling For UAVs Using a Combined GPS-Machine Vision Guidance, AIAA Paper #2004-5350, 16 August 2004

KEYWORDS: Aerial refueling, guidance system, unmanned aircraft

N101-074 TITLE: Robust, Thin Resistive Films

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Advanced Development Program Office NAVAIR, 4.12.7, Non-ACAT

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop thin resistive films capable of withstanding organic matrix composite manufacturing process stresses and associated handling requirements.
NOTE: The prospective contractor(s) must be US owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Operating Manual.

DESCRIPTION: Carbon nanotubes (CNT) have been demonstrated to have exceptionally high values of conductivity. They have been used to make conductive inks, conductive sealants, and conductive fibrous mats, among other applications. One advantage of using CNT over carbon black is that the quantity of filler needed is considerably less. In fact, conductive films can be produced using CNT that remain transparent to visible light. One other potential application for CNT is a conductive coating in resistive or conductive thin films. Current resistive and conductive thin films use either carbon particles dispersed in an ink or sputtered metal films. Neither of these materials is very robust, often breaking down in handling operations or when bent around tight radii. The low filler concentration required and high aspect ratio of CNT used in inks to achieve comparable conductivities makes it possible that these CNT films will be more robust and durable.

PHASE I: Demonstrate the feasibility to produce a thin conductivity film that can withstand rigorous flexing and bending. Develop a cost estimate for making hundreds of square feet of the material. The coating must also exhibit good ASTM tape peel, abrasion and electrical stability under heat and humidity. Furthermore demonstration of modest sized (A4) coated sheets should be demonstrated and shown to have excellent uniformity (<5% Rs variation across surface) and repeatability from sheet to sheet. A test article will be required to demonstrate that resistivities through the range of 10 ohms/square to 1000 ohms/square can be produced and that these films can be bent around a quarter inch diameter mandrel>10 times without a more than 5% change to the resistivity. These coating should also be tested to demonstrate mechanical and environmental durability. Feasibility to scale the entire deposition process should also be made evident.

PHASE II: Scale up the deposition process to produce several hundred square feet of material. Characterize the film with respect to environmental stability and handling durability. Large area test articles will be prepared and the films characterized. The films will be used to demonstrate the ruggedness of the CNT coating and stability to a variety of environments, including humidity, temperature, and salt fog.

Note: The prospective contractor(s) must be US owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Operating Manual. The selected contractor and/or subcontractor may be required to acquire and maintain a secret level facility and Personnel Security Clearance in order to perform in Phase II of this contract as set forth by Defense Security Service (DSS) in order to gain access to classified information. The selected contractor may be required to safeguard classified information IAW DoD 5220.22-M during advanced phases of the contract.

PHASE III: Complete the development of the technology by Navy qualification testing and maturing the manufacturing process. Transition the technology to a Navy airborne or ship system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Resistive films can be used in variety of commercial applications including touch screens, e-paper, and solar panels.

REFERENCES:

1. Ning Li, Yi Huang, Feng Du, Xiaobo He, Xiao Lin, Hongjun Gao, Yanfeng Ma, Feifei Li, Yongsheng Chen, and Peter C. Eklund, :Electromagnetic Interference (EMI) Shielding of Single-Walled Carbon Nanotube Epoxy Composites," Nano Lett., 2006 6 (6), pp 1141-1145.

2. Yonglai Yang, Gupta C. Mool, Dudley L. Kenneth, Lawrence W. Roland, "A Comparative Study of EMI Shielding Properties of Carbon Nanofiber and Multi-Walled Carbon Nanotube Filled Polymer Composites, "Journal of Nanosciences and Nanotechnology, 2005, vol. 5, no. 6, pp. 927-931.

3. Yonglai Yang, Gupta Mool C., and Kenneth L. Dudley, "Towards Cost-Efficient EMI Shielding Materials Using Carbon Nanostructure-Based Nanocomposited", Nanotechnology, 2007, vol. 18 345701.

KEYWORDS: Carbon nanotubes, thin films, conductive polymers, nanotechnology

N101-075 TITLE: Electric Field Tunable Multi-Ferroic Phase Shifters for Phased-Array Applications

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

ACQUISITION PROGRAM: IMS (Integrated Warfare Systems - Radar component) TBD

OBJECTIVE: Develop and demonstrate high power electric field tunable multi-ferroic material based phase shifters for X-band phased array applications.

DESCRIPTION: Modern active electronically scanned phased array radars provide outstanding capability but are unfortunately expensive. To a large degree, this results from the need for power and low noise amplifiers at each antenna element. A promising alternative architecture shares the amplifiers among many elements and thus requires a phase shifter at each element. This choice imposes challenging power handling and insertion loss requirements on the phase shifter. Historically, ferrites are the materials of choice for tunable reciprocal and non-reciprocal microwave devices where tuning is realized by varying a bias magnetic field, H, because they exhibit very low losses. But magnetic field tuning is slow, and requires large current. In addition, such devices cannot be easily miniaturized or integrated with semiconductor processing technologies which will result in lower cost.

Multi-ferroic materials provide a tantalizing alternative combining the tunability of ferrite materials with voltage control and miniature size. The possibility of electric field tuning in devices based on multi-ferroic materials arises from coupling of a ferroic material to piezo-electric material. Recent demonstration of voltage tuning of a composite multi-ferroic ferrite-piezoelectric resonators is significant in this regard. When bilayers of yttrium iron garnet (YIG)-lead zirconate titanate (PZT) and YIG/lead magnesium niobate–lead titanate (PMN-PT) bilayers are subjected to an electric field, mechanical deformation in the piezoelectric produces a frequency shift in the magnetic response of the ferrite. Such electrical tuning is rapid, requires minimal power, and has the potential to be integrated in a hybrid manner with other circuits.

It can be expected that device improvements that build on existing experiments will lead to a laboratory demonstration of a multi-ferroic phase shifter exhibiting reasonable power handling and low insertion loss, in a compact, easily hybridized form. The goal of this program is to utilize multi-ferroic devices in S-Band (2-4 GHz) C-band (4-8 GHz) or X-Band (8-12 GHZ) phase shifter networks. Successful proposals will support a digital phase shifter element demonstration capable of handling output power levels of > 1W peak, > 0.2W average, switching delay of < 1 microsecond, phase resolution > 4-bits, and < 2 dB insertion loss across a complete band.

PHASE I: Demonstrate, using test results of the performance of suitable multi-ferroic devices, that the phase shifter along with its required dc magnetic field bias having the specifications listed in the description above may be successfully fabricated in a multi-ferroic based planar technology.

PHASE II: Fabricate, test, and deliver two multi-ferroic phase shifters in a conventional connectorized microwave fixture, with integrated planar dc magnetic bias, meeting the specifications of Phase I, along with a compatible control interface suitable for laboratory demonstration.

PHASE III: Target industrial partners for technology transition with potential integration into one or more Navy systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed technology is expected to result in a high level of interest in these circuits for current and future generation phased-array radar systems.

REFERENCES:

1. J. Teti, and F. Darreff, “MEMS 2-bit Phase-Shifter Failure Mode and Reliability Considerations for Large X-Band Arrays,” IEEE Trans. Microwave Theory and Tech., Vol. 52, No. 2, pp. 693-701, 2004.

2. W. J. Kim, W. Chang, S. B. Qadri, H. D. Wu, J. M. Pond, S. W. Kirchoefer, H. S. Newman, D. B. Chrisey, J. S. Horwitz, “Electrically and magnetically tunable device using (Ba, Sr) TiO3/Y3Fe5O12 multilayer,” Appl. Phys. A 71, pp.7-10 (2000).

3. G. Srinivasan and Y. K. Fetisov, “Ferrite-piezoelectric layered structures: Microwave magnetoelectric effects and electric field tunable devices,” Ferroelectrics 342, 65 (2006).

4. Ce-Wen Nan, M. I. Bichurin, S. Dong, D. Viehland, and G. Srinivasan, “Multiferroic magnetoelectric composites: Historical perspective, status and future directions,” J. Appl. Phys. 103, 031101 (2008).

KEYWORDS: Multi-ferroic, ferrite, piezoelectric, phase shifters, phased-array radar

N101-076 TITLE: Platform for Developing and Evaluating Spatio-temporal Cognition in Autonomous Agents

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop and demonstrate a platform for building and evaluating spatio-temporal reasoning capabilities of virtual autonomous agents.

DESCRIPTION: Land-based and airborne semi-autonomous systems are being increasingly used in critical missions such as search and rescue, information surveillance and reconnaissance (ISR), and explosive ordnance disposal (EOD). However, interactive navigation capabilities for such systems are cumbersome to use and can limit the scale of operations.

The existing methods of human interaction with robots and other autonomous systems such as unmanned aerial vehicles (UAVs) are platform specific and severely limited (Burke et al, 2004). For instance, Lauria et al (2002) illustrate the development of a natural language interface that employs shallow text processing. Likewise, Skubic et al (2007) show the utility of sketch based interaction for controlling a team of robots. However, these approaches ignore the connection of human robot interaction to spatio-temporal cognition, and world knowledge as a basis for more robust and efficient interaction. Moreover, presently evaluating the impact of such interaction methodologies is difficult due to heterogeneity of approaches and make the comparison of alternative approaches infeasible (Olsen, 2006).

Navigational and extra-navigational autonomy of these systems needs to be increased along with a provision of robust interfaces for natural language and sketch-based interaction using deeper spatio-temporal reasoning abilities (e.g., Roy, 2005). Developing navigation capabilities and corresponding interaction techniques for specific platforms can lead to brittle and unportable spatio-temporal reasoning systems that fail to perform outside their designed environments. Furthermore, the development and evaluation process of such capabilities in physical systems can be time consuming, expensive, and can result in unpredictable performance. Therefore, an integrated platform for developing and evaluating interactive spatio-temporal reasoning capabilities of cognitive agents is needed. The desired capabilities for such a platform are as follows: (1) author and generate scenes and scenarios that represent the target environment and the navigational task for autonomous agents (2) embed or integrate autonomous agents in a plug-n-play manner (3) interact with autonomous agents; such as submit high-level navigational commands in one or more modes such as natural language and/or sketching (4) observe and record the reasoning and activities of autonomous agents in their environments (5) measure, analyze, and report the performance of virtual autonomous agents.

PHASE I: Survey the representation approaches for portable, interactive, spatio-temporal reasoning and select a candidate spatio-temporal representation and reasoning system. Develop component architecture for a system that enables development and evaluation of spatio-temporal reasoning in autonomous agents and demonstrate the feasibility of desired capabilities.

PHASE II: Develop a detailed design and implement a prototype of the system proposed in Phase I. Demonstrate the ability of the prototype to meet the desired capabilities by creating and executing several navigation problem scenarios of varying complexity.

PHASE III: Fully develop the system into one or more commercial products. Transition the technology for use in the (X: Navy FNC?) and for commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL USE APPLICATION: Robust interactive multimodal interaction for navigational and extra-navigational capabilities in virtual and physical autonomous agents has wide-spread application both in other branches of DoD and industry. Potential applications include interactive training and tutorial systems, gaming, and simulation.

REFERENCES:
1. Burke J.L., Murphy, R.R., Rogers, E., Lumelsky, V.J., & Scholtz, J. (2004). Final report for the DARPA/NSF interdisciplinary study on human-robot interaction. IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, 34(2):103–112.

2. Lauria S., Bugmann G., Kyriacou, T. & Klien E. (2002). Mobile robot programming using natural language, Robotics and Autonomous Systems, 30, 171-181.

3. Olsen, D.R., & Goodrich M.A. (2006). Metrics for evaluating human-robot interactions, Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-Robot interaction, Salt Lake City, Utah, USA pp. 33 -40.

4. Roy, D. (2005). Grounding words in perception and action: computational insights, Trends in Cognitive Science, Vol 9 (8)

5. Skubic, M., Anderson, D., Blisard, S., Perzanowski, D., Shultz, A. (2007). Using a hand-drawn sketch to control a team of robots, Autonomous Robots, 22 (4): 399-410.

KEYWORDS: Virtual environments, autonomous systems, spatio-temporal reasoning

N101-077 TITLE: Forward Bathymetry Sensing for Safe High Speed Boat Operation

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Unmanned Cooperative Cueing and Intervention FNC & PMS 403 UMV

OBJECTIVE: Develop a forward looking bathymetry sensor for high speed surface boats to provide them with safe stopping or turning to avoid hitting an obstacle. This sonar should be able to detect the bathymetry to enable a manned driver or autonomous autopilot to either stop, turn, or reduce speed in order to operate safely. This capability will increase the ability to operate at higher speed with increased safety near shore for both manned boats and the new unmanned surface vehicles.

DESCRIPTION: The U.S. Navy Forces operate high speed surface craft/boats near shore and in riverine environments. During high speed operations, the craft/boats operate with limited insight to the bathymetry in front of them. In these riverine and near shore environments, the bottom environment can change significantly in a very short time window because of sand bars and shoals moving into areas that were once navigable. Therefore it is important for the small boats to be able to detect the bathymetry at high speeds so they can safely navigate these waters.

These boats can travel in excess of 40 knots. During these high speed operations, impacting a submerged obstacle or a sand bar can be deadly to the crew and can cause unreparable damage to the surface craft. Currently for safe operation, the craft/boats limit their speed which then increases their vulnerability or reduces mission effectiveness. The operational users desire to have a sensor that can detect the bathymetry far enough in advance that the boat driver can either maneuver around obstacles or stop the craft before an impact with a submerged object or with the sea floor.

The physics around this problem will require an innovative solution. The transducer will have to be designed to reduce cavitation at these high speeds in order to eliminate bubbles that will prevent reception at the transducer. The system will need to be designed for ease load and unload onto trailer and be robust enough to operate at these high speeds and vibrations.

The bathymetry sonar that can operate at high speeds should be capable of measuring the bathymetry to a depth of 100 ft and have a view far enough in front of the boat to allow the operator to safely maneuver the boat. The sonar should be capable of operating at a maximum speed of 50 knots, and should have at least a 60 degree field of view.

PHASE I: Develop a preliminary design for the high speed bathymetry sensor. Provide the theoretical predictions of the system and develop a technology development plan for Phase II. The deliverable should be a preliminary design of the system. If the design or components of the design are high risk, a risk reduction plan should be included.

PHASE II: Complete the system design. This task should include any risk reduction tests, detailed design review, and test plan. Fabricate 3 prototype high speed bathymetry sonars and complete laboratory and development tests. Integrate sonar onto a government furnished 11m Rigid Hull Inflatable Boat (RHIB) located at SPAWAR San Diego. Support at sea tests of the prototypes on a government provided 11m RHIB located in San Diego.

PHASE III: Phase III will include the redesign of the sonar incorporating the lessons learned from the 3 prototype units in Phase II. Fabricate a production like system for government testing. Develop documentation of the system for transition into an acquisition program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The tourist industry uses many high speed boats to give tours of the shoreline. These include large high speed raceboats that carry up to 100 people and small 12 person boats that are used for amusement. these boats usually go to known locations that are safe for their operation. Installation of this sonar could increase the boat's touring areas as well as increase the safety during boat operations.

The high speed ferry industry continues to increase their speed into this range. Many new catamaran ferries are reaching speed in excess of 30 knots. These sonars could be used to prevent an accident of these high value ships.

REFERENCES:
1. http://www.bassresource.com/fishing/depthfinder_fishfinder.html

2. http://www.fieldandstream.com/article/Gear/Sonar-on-the-Go

KEYWORDS: sonar; bathymetry; USV; small boat

N101-078 TITLE: Dual Well Focal Plane Array (FPA)

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: FNC: EMW FY11-01 – Precision Urban Mortar Attack (PUMA)

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Design and build an inexpensive, imaging sensor that could be read much like a Charge Couple Device (CCD). The Dual Well FPA differs from a conventional CCD FPA in that each pixel in the FPA would have two charge wells -- charge well A and charge well B. The FPA would have the ability to gate imagery in well A to detect laser energy at 1064nm (with pulse durations as short as 10ns, pulse repetition rates as high as 20 KHz, with as little as 25 uJ per pulse) and charge well B could be used as a passive imager to provide video imagery at frame rates up 60 hertz.

DESCRIPTION: The current state of technology in FPA imaging systems has provided a number of technologies (silicon, InGAs, HgCdTe, and CMOS imagers) that are sensitive to near infra-red energy, making many of them useful for detecting laser energy at 1064nm. The problem with using a conventional imager to provide a see-spot capability for a laser designator system is that in order to capture the reflected laser pulse energy, the imager must be gated in time to coincide with the time of arrival of the reflected laser pulse from the target. By gating the imager to "see" the laser spot and not allowing the charge wells to charge except when the laser return is expected, the imager sacrifices all surrounding video imagery. That is, the only thing that is often seen in the video frame is the laser spot itself. The resultant scene is often too dark to discern any details except for the spot because the charge wells within the FPA did not receive enough photons from the surrounding scenery to produce a useful image due to the limited gate time allotted to the laser pulse. (The gate time of the laser is minimized to limit noise.) In order to overcome this phenomenon, the FPA could be gated sparingly to see some of the laser pulses and could operate as a passive imager the remainder of the time. This approach sacrifices frame rate in the passive imager and sacrifices the ability to see each laser pulse. With a dual well FPA, one well (well A) could be gated at the laser pulse repetition rate while the other well (well B) could be operated in the passive mode for conventional imaging and a video processor could interleave the gated image with the passive image to produce a composite image that contained the background imagery as well as the laser pulse imagery.

PHASE I: Develop Dual Well FPA design that includes specification of technology employed, and estimates of cost.

PHASE II: Develop and demonstrate a prototype Dual Well FPA in a realistic environment. Conduct testing with a laser designator system.

PHASE III: this technology is expected to transition to the PUMA FNC, and, if successful, may become part of a micro-pulsed laser designation system that is widely used within military applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These Dual Well FPA's could be used in a variety of military, civilian, and law enforcement application. They could be used in security, surveillance, and border control systems where gated imagery with active illumination could be blended with passive imaging applications. Active illumination could be a strobe light at micro-pulse intervals at visible or near infra-red wavelengths and the subject would not even be aware that they were being imaged.

REFERENCES:
1. http://www.freepatentsonline.com/

2. www.dtic.mil/ndia/2008gun_missile/FreemanBryan.pdf

KEYWORDS: Inexpensive, CCD, Dual-Well, FPA, focal plane array, laser designator

N101-079 TITLE: fMRI compatible hypo-hyperbaric system for diving research and hyperbaric medicine

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Create an fMRI compatible hypo-hyperbaric system to study diving and hyperbaric medicine.

DESCRIPTION: The physiological mechanisms underlying health threats associated with manned undersea operations such as decompression illness (DCI; decompression sickness, arterial gas embolism) and oxygen toxicity are currently not well understood. In addition, the mechanisms underlying the therapeutic benefit of hyperbaric oxygen treatment (HBOT) and its applications (e.g., DCI, traumatic brain injury, stroke) need to be validated. Magnetic resonance imaging (MRI) is now commonly used to generate detailed images of the soft tissue anatomy of the human body. Functional MRI (fMRI) is increasingly employed in the study of the functioning brain. Presently, we are unable to utilize these advanced imaging technologies to study the physiological effects of pressure and gas in situ.

PHASE I: Determine feasibility of constructing an MRI compatible hyper-hypobaric system for use in decompression studies and hyperbaric research. Develop a detailed design of the system for an 80 kg subject in a 3-Tesla imager, with the necessary optical/electronic pass-through for the instrumentation of the research subject, and identify experimental methods that will leverage this technology.

PHASE II: Construct a prototype MRI compatible hyper-hypobaric system. Test the system for operational safety at pressures equal to or exceeding a 0.2-3.0 ATA range inside an MRI chamber. Certify the system for animal and/or human testing.

PHASE III: Develop imaging techniques and experimental methodologies to address research questions identified in Phase I. Introduce the system for use at Navy Research Laboratories (e.g., Naval Submarine Medical Research Laboratory, Naval Medical Research Center, Navy Experimental Diving Unit).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Universities, research institutions, and medical treatment facilities that employ hyperbaric chambers would clearly benefit from this technology. Current use of imaging techniques such as MRI in HBOT research/clinical trials is limited, and both technologies cannot be employed simultaneously.

REFERENCES:
1. Bennett, P. and D. Elliott (1993). The physiology and medicine of diving, London, W.B. Saunders Company

2. Huettel, S. A., A. W. Song, et al. (2004). Functional magnetic resonance imaging, Sinauer Associates.

3. Neuman, T. S. and S. R. Thom (2008). Physiology & medicine of hyperbaric oxygen therapy, Saunders.

4. Workman, W. T. (1999). Hyperbaric Facility Safety: a practical guide, Flagstaff, Best Publishing.

KEYWORDS: diving; hyperbaric medicine; MRI; fMRI, decompression sickness; hyperbaric oxygen therapy

N101-080 TITLE: DUAL BAND SAL SEEKER Read Out Integrated Circuit (ROIC)

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA 242; APKWS; ACAT III

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective of this SBIR is to develop a read out integrated circuit (ROIC) for an advanced, integrated Dual Band Semi-Active Laser (SAL) receiver. The ROIC shall provide timing information for returns received by any detectors. The critical new design elements of this SBIR shall provide support for alternative detectors that can utilize returns from both eye hazardous and eye-safe lasers. The ROIC shall support at least 16x16 detector elements in order to increase weapon system effectiveness while maintaining the same active area as the conventional quad-cell.

DESCRIPTION: A semiactive laser sensor consisting of a, at a minimum, 16x16 dual-band detectors integrated with a ROIC architecture would develop a dual wavelength sensor for future SAL seekers. The increased number of detectors provides the precision required for effective guidance while still retaining a low cost, strap down sensor design. Integrating all necessary SAL analog functions in the ROIC and, therefore, providing a purely digital interface would be advantageous.

Optimal responses to this SBIR will address a proposed approach and analyze:
• how accurate timing and intensity information can be provided,
• how, during target acquisition, detection and code correlation can be near continuous, (ROICs typically have “live” and “dead” time to allow readout of data stored in sample /holds for each detector. Consequently, some combination of fast readout of data and/or adequate buffer lengths must be provided.),
• predicted power consumption, and
• how the ROIC may be integrated with GFE detector arrays.

Live time is defined as the period, or percentage, of time that the ROIC is actively collecting data. Dead time is defined as the period of time that the ROIC is not actively collecting data but is performing other tasks such as reading out buffered data. It is conceivable that a ROIC could be buffered in such a manner as to simultaneously collect and read out data. In such an advantageous system, dead time would be zero or not defined.

PHASE I: In Phase I of this SBIR effort, the contractor shall investigate approaches to developing the ROIC as described above. This will include methodologies and electronics required in order to test the resultant ROIC. Based on the outcome of the assessment, the contractor shall prepare a preliminary design for the ROIC and shall provide with the design a description of the likely cost, in quantity, of producing such a device.

PHASE II: In Phase II of this SBIR effort, the contractor shall finalize the design and construct a prototype that could be tested in a laboratory setting. The prototype must demonstrate achieving the specifications listed in order to move to Phase III. An option for this phase will be to integrate a government provided detector array and test the resultant assembly. Classification guide required for Phase II effort.

PHASE III: In this phase, the resultant ROIC shall be integrated with a government provided detector and packaged in a military package for field testing which will include both ground/tower and helicopter testing. Associated electronics and test sets required to collect meaningful data shall be provided by the contractor.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of eye-safe lasers could open up commercial applications of semi-active laser guidance packages, which are now restricted by safety concerns around the 1.06 micron lasers.

REFERENCES:

1. Hintz, Robert "Dual Band Semi-Active Weapons Systems" Proceedings of Military Sensing Symposium, National Meeting Nov 2007, SENSIAC Atlanta 2008.

2. JPUB-01

KEYWORDS: Semi-Active Laser, SAL, Weapon, Dual-band, Read Out Integrated Circuits, Eye-Safe, Precision Guidance

N101-081 TITLE: Novel Volumetric and Gravimetric Oxygen Sources and Packaging Suitable for Unmanned Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: PMS 403, PMS 399, PMS 394, PMS 404

OBJECTIVE: Investigate and demonstrate novel volumetric and gravimetric oxygen sources for underwater applications with specific energies of 500-700 Whrs/kg at the system level.

DESCRIPTION: Underwater vehicles and weapons must operate in air-independent environments. There is the need to investigate novel oxidizer sources for the operation in the absence of air, and at the same time meet safety, cost and underwater operation requirements.

Underwater vehicles will serve as key elements in integrated operations of future surface ships and submarines, providing a range of support functions including autonomous surveillance, mine counter measures, and special forces transport. However, current power sources for these vehicles (rechargeable silver-zinc or lithium ion batteries or high-energy primary batteries) do not meet the energy requirements for future missions, or they impose a tremendous logistics burden on the host vessel. Fuel cells offer a viable option for meeting mission energy requirements, and at the same time, they can reduce the host vessel logistics burden if the fuel and oxidizer can be stored in a safe, high energy density format.

Fuel cells operating on hydrogen or more complex fuels (such as high energy density hydrocarbons) and oxygen are attractive as underwater power sources because they are efficient, quiet, compact, and easy to maintain. The total energy delivered by a fuel cell system is limited only by the amount of fuel and oxygen available to the fuel cell energy conversion stack. Unlike ground and air transportation fuel cell systems that only require an onboard fuel, underwater vehicles must carry both the fuel and the oxygen source because the oxygen concentration in the ocean is insufficient to meet vehicle power requirements. The underwater vehicle oxygen source must possess a high oxygen content (both weight and volume based) to accommodate the weight and volume constraints of the vehicle design, provide oxygen in a throttleable manner to load follow the fuel cell, and be amenable to safe handling and storage onboard submarines and surface ships.

Gaseous oxygen storage does not provide adequate storage densities, while liquid oxygen storage introduces challenges with handling and storage. Other liquid sources, such as hydrogen peroxide (H_2O_2) require compact, efficient, controllable conversion methods to produce oxygen and handle reaction byproducts. Solid-state oxygen sources such as sodium chlorate ($NaClO_3$) and lithium perchlorate ($LiClO_4$) possess high oxygen contents and are stable under ambient conditions; however, decomposition of these materials to gaseous oxygen typically employs thermal methods that are often difficult to start, stop, and control.

Therefore, innovative approaches to oxygen storage and generation are sought to address air-independent propulsion needs. The oxygen storage material may be a liquid or solid and may be fed to the conversion system as a liquid, a solid, or a solid in a carrier fluid (preferably water) as a slurry or a solution. The ability to mechanically recharge or replenish the oxygen source should be considered. To meet nominal undersea vehicle power requirements, throttleable oxygen delivery rates should be sufficient to power a typical fuel cell stack from 50 W to 5 kW. Oxygen storage capacity should be scalable to provide a minimum of 50 kilograms of useable oxygen gas. The available oxygen capacity should be maximized on a total system weight basis (i.e. weight percent oxygen), while maintaining a high volumetric density for the overall system.

PHASE I: During Phase I: Demonstrate the volumetric and gravimetric oxygen source analyses to meet the specific energies of 500-700 Whrs/kg at the vehicle power system level. Conduct laboratory scale testing (TRL 2-3) to demonstrate feasibility of the system concept with high efficiencies (>80%) and evaluate the safety and handling criteria for such oxidizers. Develop a vehicle-level oxygen source system schematic.

PHASE II: Based on Phase I assessments, further develop and optimize prototype demonstrations (TRL 4-5) and scalability approaches for the described system, and demonstrate a degree of commercial viability. Complete safety analyses.

PHASE III: Phase III will be awarded after Phase II prototype demonstration and safety analyses are complete. The system will be ready for in-water demonstration in actual hardware and demonstrate a TRL 6. This demonstration must be completed with a commercial partner and with a commitment from a transition sponsor.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology can benefit ocean surveillance, underwater mapping industry.

REFERENCES:

1. UUV Master Plan (http://www.navy.mil/navydata/technology/uuvmp.pdf)

2. Fuel Cell Systems, Leo J. M. J. Blomen, Michael N. Mugrewa, Ed., Plenum Publication Corp., NY (1994).

3. Undersea Vehicles and National Needs, National Research Council, National Academy Press, Washington D.C. (1996).

4. An Assessment of Undersea Weapons Science and Technology, National Research Council, National Academy Press, Washington D.C. (2000).

5. Russel R. Bessette, et al., J. Power Sources, 80 (1999) 248-253.

6. Øistein Hasvold, et al., J. Power Sources, 80 (1999) 254-260.

KEYWORDS: air-independent energy sources; liquid oxidants, volumentric/gravimetric oxidizers; replenishability; underwater applications

N101-082 TITLE: Development of Advanced Compact Energy Recovery Pumping System for Shipboard Seawater Reverse Osmosis Desalination

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 501 as well as POM-10 advanced shipboard desalination FNC

OBJECTIVE: Develop an advanced compact energy recovery pumping system for use in 2,000 to 12,000 gal/day seawater reverse osmosis (RO) desalination systems found on many current and future Navy surface combatants and submarines. Such a pumping system will provide for reduced energy consumption, improved reliability, less required maintenance, and lower noise emissions of shipboard desalination systems.

DESCRIPTION: RO desalination has become the Navy standard for the shipboard production of freshwater since its introduction into the Navy in the late 1980s. In the RO process, high pressure seawater (typically 800 to 1000 psi) is forced through a semi-permeable membrane which allows water passage to the exclusion of salt. To obtain this high operating pressure on current shipboard systems, seawater from the firemain or auxiliary seawater system is filtered through a series of strainers and string wound cartridge filters (down to a nominal filter rating of 3-µm) and then processed in a high pressure pump of rated capacity of 40 gal/min (for the 12,000 gal/day Navy Standard RO plant) or less. The resulting high pressure seawater is then fed into the RO membrane elements, where approximately 20% of the feed water permeates through the membrane as purified fresh water. The remaining concentrated seawater is ultimately sent to a ship overboard system for discharge. Due to minimal pressure drop through the RO elements, the pressure of this concentrate stream is still close to the feed seawater pressure and needs to be reduced before entering most ship overboard systems. Currently, pressure regulating throttling valves are used on shipboard RO systems to reduce the pressure of the concentrate stream.

Since the Navy introduced RO plants into the Fleet, improved technologies have been developed that can have a significant ability to lower the energetics and costs of plant operation as well as lessen vulnerability during operation. Energy recovery devices have been developed which can decrease required power by as much as 40% by recovering the energy in the concentrate steam typically lost through the pressure regulating throttling valve and returning it to the high pressure pump. These devices can also improve pump reliability and decrease maintenance requirements, in addition to lowering noise emission, by allowing the use of slower pump speeds. The efficiency of some commercially available recovery devices can exceed 90%.1 The issue for Navy applications is that the existing commercial energy recovery devices have been designed for large capacity RO systems and are extremely limited in availability and efficiency for the flow ranges of smaller capacity desalination plants, typical of most shipboard RO systems.2

The proposed energy recovery system should be able to recover more than 80% of the energy typically lost in the high pressure RO concentrate discharge. The developed system may either be paired to existing high pressure pumps (allowing these pumps to run more efficiently and reduce required maintenance actions on these pumps) or developed as a smaller, lighter integrated pumping system for achieving required feed pressures to the shipboard RO system.

GUIDELINES FOR NEW TECHNOLOGY:
1. Capable of maximum continuous discharge pressure of 1,200 psi
2. Input power not greater than:
a. Threshold: 15 kWh/kgal
b. Objective: 10 kWh/kgal
3. Capable of operating in a seawater environments with total dissolved solids (TDS) concentrations between 25,000 and 42,000 mg/L and seawater temperatures between 34oF and 105oF
4. Capable of operating on feed waters containing suspended particles of 10-µm and less
5. Capable of operation in a military environment
6. Volume of pump and motor
a. 12,000 gallons per day at 40% recovery, Threshold: 6.5 cu. ft; Objective 3 cu. ft
b. 2000 gallons per day at 40% recovery, Threshold 1.5 cu. ft. Objective 0.6 cu. ft
c. linear interpolation for intermediate pump capacities.
7. High level of availability and reliability
a. Phase II Threshold: 4000 hours
b. Phase II Objective: 8000 hours
8. Available process streams include:
a. Filtered Seawater
b. RO Concentrate
c. Electricity (440 VAC, 3 Phase)
d. Compressed Air

PHASE I: Demonstration of pumping system efficacy, at a subscale level if necessary, in a laboratory environment, utilizing at least a model seawater mixture of relevant composition (e.g., ASTM synthetic seawater3 or “Instant Ocean”) for at least 6 consecutive hours. Longer term and more strenuous testing is of interest to further clarify energy efficiency, reliability, and operational availability. Phase I Option – Produce designs for full-scale device. Perform additional testing on model mixture to determine longer-term operational changes and/or pursue and evaluate changes and improvements to pump.

PHASE II: Demonstration of a full-scale device with natural seawater, assembly of full scale pumping system to validate operation. Deliverable will be utilized to prove performance at a Navy natural seawater test facility. Phase II Option – Advanced design to improve reliability and/or reduced system size/weight.

PHASE III: Commercialization of device in combination with a Navy-relevant desalination system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private-sector will benefit from this technology wherever smaller scale reverse osmosis plants are operated, in the range of 2,000 to 12,000 gallons per day, such as for small municipalities.

REFERENCES:
1. "Comparative Study Of Various Energy Recovery Devices Used In SWRO Process" by A.M. Farooque, A.T.M. Jamaluddin, Ali R. Al-Reweli, P.A.M. Jalaluddin, S. M. Al-Marwani, A.S. A. Al-Mobayed, and A. H. Qasim

2. "Energy Efficiency in Reverse Osmosis Systems" by Murray Thomson (http://www.adu-res.org/pdf/Loughborough.pdf)

3. ASTM D1141 – 98 (2008) Standard Practice for the Preparation of Substitute Ocean Water.

KEYWORDS: energy recovery; high pressure pumps; seawater reverse osmosis desalination

N101-083 TITLE: <u>Fast, High Resolution 3-D Flash LIDAR Imager</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: Sea Shield FNC, PMS-495

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OBJECTIVE: The objective is to develop an innovative fast, high resolution 3-D flash LIDAR imager to detect targets in the surf zone (SZ) and very shallow water (VSW) from a Tactical UAV. In particular, a high resolution, high dynamic range, fast gate, high integration/sampling rate 3-D Flash LIDAR imager for underwater imaging

DESCRIPTION: The current 3-D Flash LIDAR imaging systems have shown the usefulness of 3-D imaging and many lessons have been learned such as the need for narrow gate widths and higher resolution. The ability to detect underwater targets in the SZ with a 3-D volumetric imaging system has been demonstrated. This effort is to develop a 3-D Flash LIDAR imager to detect targets in the SZ and VSW from a Tactical UAV. This development will require innovations at the chip level to achieve improved pixel count (100,000 pixels or greater), high number of narrow time samples (40 or more), faster gate times (less than 3 nanoseconds), and better SNR. These advancements will provide airborne, ground-based, and sub-surface systems with imaging capabilities beyond those currently available all with reduced cost, size, weight, and power requirements.

PHASE I: Design a high resolution 3-D Flash LIDAR imager for the detection of targets in the SZ and VSW from a TUAV

PHASE II: Fabricate and test the high resolution 3-D Flash LIDAR imager developed in Phase I

PHASE III: Develop and integrate the high resolution 3-D Flash LIDAR imager into the Sea Shield FNC and/or the acquisition programs COBRA and ALMDS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The ability to enhance detection of littoral zone targets would also be useful in natural disaster assessment and would also benefit coastal zone surveys, environmental assessments, and search and rescue systems.

REFERENCES:

1. Rapid Overt Airborne Reconnaissance (ROAR) for Mines and Obstacles in very shallow water, surf zone, and beach; Proc. SPIE, Vol. 5089, 214 (2003); Steve Moran, et.al, Lite Cycles Incorporated (USA).

KEYWORDS: 3-D Flash LIDAR, Littoral MCM, Airborne Reconnaissance, Underwater Imager, 3-D Camera, Mine Detection

~~N101-084 TITLE: Strained Layer Superlattice (SLS) Dual Band Focal Plane Array (FPA)~~

~~TECHNOLOGY AREAS: Sensors, Electronics~~

~~ACQUISITION PROGRAM: PMA 263~~

~~OBJECTIVE: The objective of this SBIR is to demonstrate a large format (1k x 1k) dual band (MWIR/LWIR) FPA with good quantum efficiency (> 60%), and greater than 98% operability. A preferred approach would be to build on the development efforts sponsored by MDA to build large format dual band (LWIR/LWIR) SLS FPAs. The MDA program is looking at multiple bands in the LWIR region to address cold targets against the cold background of space. This SBIR can potentially utilize the large format Read Out Integrated Circuits (ROICs) developed by the MDA effort, and focus the SBIR resources on the development of the dual band (MWIR/LWIR) materials, required for terrestrial applications, and the fabrication of the FPA.~~

~~DESCRIPTION: Strained Layer Superlattice (SLS) detectors are based on deposition of numerous very thin layers of III-V materials to optimize absorption and quantum efficiency in the wavelength bands of interest. A useful level of mechanical strain must be developed between the material layers to optimize performance. Once a recipe (multiple layers of III-V materials with varying thickness) is established then it must be deposited and prepared for connection (typically bump bonding) to the ROIC. The completed FPA must then be evaluated for sensitivity, uniformity, dynamic range, and operability.~~

~~PHASE I: Phase I of the large format dual band SLS FPA demonstration is to create the recipe for obtaining the desired performance. The success of this phase could be demonstrated with the construction of a small detector array with the desired properties.~~

~~PHASE II: The Phase II effort would use the recipe from Phase I to generate the detector material required for connection to a large format dual band ROIC (provided by MDA). Once the SLS FPA has been fabricated then its performance would be evaluated against the program goals.~~

~~PHASE III: In Phase III the SLS FPA would be incorporated into a camera system that would address the needs of a specific platform (TBD). This effort would allow the small business to tailor the device for a specific military application which could then be demonstrated under representative operational conditions.~~

~~PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Currently dual band (MWIR/LWIR) sensors are too expensive for most commercial applications. One of the promising aspects of SLS FPAs is the potential to reduce FPA costs significantly so that some commercial applications may arise in the areas of heat loss mapping of buildings or monitoring of environmental conditions.~~

~~REFERENCES:~~
~~1. "Mid-IR focal plane array based on type-II InAs/GaSb strain layer superlattice detector with nBn design" by Kim, H. S.; Plis, E.; Rodriguez, J. B.; Bishop, G. D.; Sharma, Y. D.; Dawson, L. R.; Krishna, S.; Bundas, J.; Cook, R.; Burrows, D.; and 4 coauthors, Applied Physics Letters, May 2008.~~

~~2. "Type II strained layer superlattice: a potential infrared sensor material for space", by Zheng, L.; Tidrow, M. Z.; Novello, A.; Weichel, H.; Vohra, S, SPIE detector meeting, January 2008.~~

~~KEYWORDS: Strained Layer Superlattice (SLS); Focal Plane Arrays (FPA), Cryogenically Cooled Detectors, Operability, large format, Dual Band~~

N101-085 TITLE: Hemostatic Agent Development

TECHNOLOGY AREAS: Biomedical

ACQUISITION PROGRAM: Navy Expeditionary Combat Command, Special Operations Command

OBJECTIVE: To explore and develop the deployment of a biodegradable, biocompatible medical aid that can be deployed at the point of use. This medical aid will have the ability to quickly stop bleeding (in less than 60 seconds) and also eliminate or reduce ambient contamination that could cause secondary infection, preserve tissue after injury and facilitate surgical speed.

DESCRIPTION: For soldiers wounded on the battlefield, hemorrhage control is essential to survival. Uncontrolled hemorrhage is the primary cause of death in the pre-hospital period for both military combat and civilian trauma incidents. Immediate action is highly effective in limiting patient mortality, since most bleeding fatalities occur within the first 30 minutes of the injury. It is generally accepted that hemostatic products for forward care in the battle zone must control bleeding quickly, be ready to use, simple to apply for first responders in combat situations, have a shelf life approaching 2 years, and prevent bacterial or viral transmission. The most critical wounds are those for which a tourniquet or simple compression are not feasible, such as internal bleeding in the chest, abdomen, and pelvis, and closed extremity fractures that are not easily accessible. Therefore, internal bleeding usually requires rapid surgical intervention.

In a battlefield setting there are three primary areas of intervention after trauma: at the injury site, in the surgical field hospital and after transport to a traditional surgical suite. There are four major wound types that need to be addressed: large diffuse injuries like burns or shrapnel; shredding wounds; penetrating wounds; and dismemberments. Each setting has the same needs: to stop bleeding in irregular wound sites, preserve tissue and allow for immediate surgical procedures in very dirty environments.

It is also very important to immobilize surface contamination. Whether it is from leaking gastrointestinal (GI) fluids causing peritonitis, airborne infectious agents, self-contamination from debris on the skin surrounding a wound site during surgery, or poorly sterilized instruments, solving the problem of war trauma-associated infection will save lives. First, wounds incurred on the battlefield are grossly contaminated with bacteria due to foreign bodies (wounding projectile fragments, clothing, dirt) being contaminated with bacteria; high-energy projectile wounding (devitalized tissue, hematoma, tissue ischemia) and delays in casualty evacuation. Most will become infected unless appropriate treatment is initiated quickly. Second, bacteria covering the soldier can be hazardous to the medical personnel. By immobilizing bacteria on wounds the contamination can also be isolated from the first responders, transporters, and finally the surgical team. Third, many secondary infections are obtained in the surgical hospital. Too much cleaning and sterilization to kill the bacteria just creates a niche for more potentially virulent strains of bacteria that have no effective treatment, such as strep. By immobilizing the native bacteria on a patient's skin prior to surgery, the patient's normal flora and fauna can help combat the foreign bacteria that are trying to gain a foothold on the patient.

The hemostatic agents previously tested for military use fall into four categories: powder/granular; solid (rigid); solid (flexible); and barrier.

1. Powder/granular agents are unable to flow into injured areas and cannot stop internal bleeding from deep wounds. The materials are opaque, preventing visual inspection of the wound prior to removal. Compression must be applied after application and the material must be removed prior to surgery. Many require mixing on site and must be applied by a responder. These hemostatic agents rely on clotting. Stasix, a powder derived from human platelets; QuikClot, zeolite granules which exhibit an exothermic reaction; Celox, chitosan granules that are difficult to remove; Instaclot, an effective composition powder, but with fragile packaging and messy removal; WoundStat, extremely effective at stopping serious bleeding, but associated with a high incidence of blood vessel thrombosis and damage to the vessel wall, and subsequently removed from Army use.

2. Solid (rigid) hemostats must be applied like a bandage or sponge and thus are unable to flow into the crevices of a deep wound. Compression must be used upon application to ensure tight adherence to the wound for clotting to take place. Bandages and sponges must be removed prior to surgery which increases the risk of rebleeding. QuikClot Advanced Clotting Sponge (ACS+), a sponge place on or in a wound to accelerate clotting, but hemorrhage arrest depends on amount of blood present; Chitosan bandage, which does not always adhere well, causing leakage. When it does adhere well it is difficult to remove and may cause rebleeding. There is a slight chance of allergic reaction.

3. Solid (flexible) hemostats can be wrapped around or stuffed into a wound, prior to applying pressure, to cause accelerated clotting. They are not able to create a tight fit in irregular wounds. These materials must be removed prior to surgery and, depending on their adherence, could cause rebleeding while being removed. Chitoflex bandage can fit into a wound and is easy to remove, but it does not adhere well enough to stop bleeding immediately; QuikClot Combat Gauze is a non-woven fiber coated with kaolin to promote clotting. It is easy to apply, removes well but does not fit tight inside irregular wounds; Stasilon is an interwoven bandage made of bamboo and fiberglass which is easy to fit a wound, but has weak absorption and weak clot formation.

4. Barrier agents incorporate swelling as part of their hemostatic action and require extra caution to ensure that the local blood supply is not reduced or stopped, which could cause additional tissue damage or even death. This is particularly crucial when using expanding foams. BioFoam is a protein hydrogel that expands to fill space and seal wounds.

A set of procedures needs to be developed for use in each wound type and within each primary intervention setting. This needs to be done using a single material, one that does not cause any immune response or adverse affect to the injured subject. The next generation of hemostatic agents, which will be used across all three settings, needs to be inert, biodegradable and biocompatible so that it does not need to be removed at any point in the treatment. They must also have these additional qualities: ability to control venous and arterial bleeding in under 1 minute; should be lightweight to carry and/or incorporate into a garment or personal protective equipment in order to automatically deploy during injury; ability for a soldier to carry it in a concentrated form that will allow for coating wounds in excess of a minimum of 50 square inches and to be self-applied with one hand; ability to be thinly sprayed on a wound in a non-temperature sensitive system; ability to be synthetically produced; ability to be stored for long periods of time, at extreme temperatures, without substantial breakdown; prevent bacterial or viral transmission by containing or killing it; ability to coat, cover and/or fill irregular voids or surfaces; be non-immunogenic to remove risk of inflammation; be biodegradable so removal is not necessary; promote healing to begin healing wounds immediately; be optically transparent to stop bleeding and be able to view the wound and operate through the material; ability to include a topical anesthetic to help ease the pain immediately after injury while waiting for additional care; ability to include color indicators to indicate the presence of different types of bacteria in wounds or on the skin; ability to immediately immobilize any contaminant at the molecular or cellular level.

The Navy will only fund proposals that are innovative, address R&D and involve technical risk.

PHASE I: Provide an initial development effort that demonstrates the scientific merit and capabilities of each of the proposed areas of (1) rapid hemostasis; (2) immobilization of surface contaminants in a wound area; (3) tissue preservation; (4) facilitation of the speed of surgery in a field setting, while preventing the entrance of contamination into the wound area; and (5) biodegradability and biocompatibility.

PHASE II: Characterization of the effective limits of the injuries as well as the effectiveness of the medical aid across each of the injury models. A polytrauma model needs to be developed to specifically test the limits of each of these new agents. This is specifically to reduce the number of different materials that need to be carried. Not only should the agents work on venous and arterial bleeding, they should also stop the evaporation of fluid after a burn, or stop the leakage of stomach acid, or stop the intestinal contents from seeping into the IP cavity of the injured person. The materials should be able to stop bleeding in liver, kidney, eyes, brain, etc. To be determined: the coating capacity as well as the durability of the various types of coatings; how long the material will stay in its intended location; frequency of re-application; correct formulation and concentration based on injury. In large, diffuse injuries like burns or shrapnel the material must have the ability to be sprayed in a very thin layer to protect and cover a large area. In shredding wounds the material must have the ability to be applied fast and in large quantities, to stop bleeding and contamination. In penetrating wounds the material must be able to be delivered into the point of penetration while also filling the void without reducing intact vasculature. In dismemberments the material must be able to coat the area of injury as well as the detached limb.

PHASE III: The goal is to develop a polytrauma material that is lightweight when carried and simple enough to be administered by an injured soldier. Ideally, a soldier would carry a device that would automatically heal the tissue and take away the pain so the soldier can stay focused; until then multiple-use materials need to be developed that have the promise of easier application, longer shelf life, will work in all environments both wet and dry, and can be used for many different types of wounds. These delivery devices and materials will save the lives and limbs of both military and civilian medical personnel all over the world. Design and adapt appropriate delivery devices for each of the different settings: field use --lightweight, easily deployed, possibly automatically deployed; deployment by doctor or medic between 15 minutes to 3 hours after injury to start the repair process, reattachment or stabilization of tissue; controlled surgical setting for reattachment of limbs or reconstruction of damage between 30 minutes and 20 days after injury.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of the molecular self-assembling medical aid could be developed for use in emergency situations and in the operating room. It could also be developed for use it in remote places of the world to help keep people alive. This type of medical aid could drive development into totally new ways to perform surgery, eliminating wound contamination in a traditional hospital surgical environment.

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KEYWORDS: Haemostasis; Wound care; Trauma; Hemorrhage, Contamination control; Surgery; Burns; Tissue preservation; Temperature control

N101-086 TITLE: Advanced Rail Materials for Electromagnetic Launchers

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: ONR EM Railgun Innnovative Prototype

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop tough, erosion/high-temperature resistant metal alloys, metal composites, or advanced coatings to be used as electrically conducting rails in an electromagnetic (EM) launcher (electric railgun).

DESCRIPTION: The US Navy is pursuing the development of an electromagnetic launcher (also known as a rail gun) for long range naval surface fire support. An electromagnetic launcher consists of two parallel electrical conductors, called rails, and a moving element, called the armature. Current is passed down one rail, through the armature, and back through the other rail. The armature is accelerated down the barrel due to the interaction between this magnetic field and current flow (Lorentz Force). An electromagnetic rail gun (EMRG) system will accelerate projectiles to hypersonic speeds, enabling ranges beyond 200 NM in less than 6 minutes of flight time while traversing the atmospheric spectrum (endo-exo-endo). The EMRG can address time-critical targets with a rate-of-fire of 6 to 10 rounds per minute while residual energy at target impact provides lethal effects. This operation occurs in an environment consisting of strong magnetic fields, high temperatures, chemical interactions and strong lateral forces on the rails and armature in the launcher bore.

A pair of electrically conductive rails act to transfer the power supply current down their length and through the moving armature creating an accelerating Lorentz force. These rails also provide lateral guidance to the armature. The face of this rail material must be able to withstand the severe mechanical, electrical, and thermal environment present in the bore of a high power electromagnetic launcher. This surface must be able to survive sliding electrical contact of an aluminum armature and polymer bore rider materials at velocities up to 2.5 km/sec, and possibly concurrent balloting loads. In order to survive these conditions, the rail material must be electrically conductive to high currents approaching 6 MA, resistant to high transient temperatures, possess high hardness and yield strength and retain these properties after thermal transients, must accommodate balloting loads, and survive exposure to molten armature metals. The material is required to resist thermal breakdown and interaction in the presence of plasma due to high current electrical arcing and shocked gas. The material must eventually be manufacturable as well as affordable for these dimensions. Alternatively, potential protective layers may be considered such as bonded claddings, jackets, surface coatings or treatments. For purposes of managing electrical current distribution and mechanical stresses, approaches that permit grading of material properties such as electrical conductivity, thermal expansion coefficient, elastic modulus near the sliding surface would be particularly attractive.

PHASE I: Develop a rail material/coating and process approach to manufacture electrically conductive bore materials. Conduct any necessary subscale tests needed to show that the proposed process is suitable for Phase II demonstration. Create sample rail coupons for static or small scale testing and verification, such as strength, erosion resistance, and conductivity versus temperature from ambient to 500 degrees C.

PHASE II: Produce samples of electrically conductive rail materials of at least 1 m length that meet the needs of the EM launcher environment. Demonstrate that the material provides the required material property characteristics described above. Further develop and demonstrate the fabrication or joining processes for creating longer sections.

Also demonstrate fabrication technology to create non-planar contact surfaces facing the bore. Produce a prototype set of coupons 1 m long and of full rail cross section, for testing in a small scale EM launcher. The EM launcher test facility may be provided as government furnished asset, or via a teaming relationship with other EM launcher test sites. Potential test sites include various scale railguns operated by Universities and Defense contractors. The results of testing may be classified. The Phase II product may become classified.

PHASE III: Develop process for full length (7-12 meters) rails with final design dimensions in other axes. The materials process developed by the Phase II effort will be applied to Navy railgun proof of concept demonstration and design efforts in the lab as well as industry advanced barrel contractors. Successful rail materials solutions will be installed in a weapon system on board ship upon transition to PEO IWS, PMS 405, ONR Program Office and integration with industry launcher manufacturers' production weapon systems that will be sent to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The materials and processes developed could be applied to any electro-mechanical applications particularly under conditions of high heat, stress, and/or current requiring both the beneficial thermal and high current aspects of conducting metals combined with the need for higher toughness and hardness with traceability to relatively long sections. Example applications could be high-speed mag-lev contacts, electrical generation facilities, high current switches and sections for re-entry protection of space-craft.

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KEYWORDS: railgun; rail; electromagnetic; conductor; wear; launcher

N101-087 TITLE: <u>Counter Directed Energy Weapons (C- DEW)</u>

TECHNOLOGY AREAS: Sensors, Battlespace, Weapons

ACQUISITION PROGRAM: Navy Counter-Directed Energy Research S&T Program (ONR 35)

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective of this SBIR is to advance the state-of the-art of counter directed energy weapons technologies and develop countermeasures for high energy lasers and/or high power microwave weapons systems in the future. Specifically, this SBIR seeks to develop specific items for a U.S. Navy weapon system, or systems, to improve their survivability characteristics and maintain established performance capabilities when attacked by High Energy, Directed Energy Weapons (DEW), with minimal cost or system impacts.

DESCRIPTION: With improved performance in both high energy lasers (HEL) and High Power Microwaves, the susceptibility of weapons systems and their sensors used in seekers or targeting system are seen as potentially degraded in a war fighting environment when impacted with DEW effects. Recent interest in protection of Unmanned Aircraft Vehicles (UAV) and their sensor suites is of particular interest. As are similarly, manned systems where performance may be degraded due to concerns or encounters with threat Directed Energy Weapons. Existing protection solutions are often taken on a case by case basis, and not cost effective or easily replicated/produced. In some cases, a limited capability may service many military requirements as well as service many commercial protection requirements – such as eye protection for laser welding systems or for sensors used in various reproduction industries. Therefore, innovations in small, lightweight, and efficient packaging for sensor protection (or electrical protection schemes for radar systems) that has a commercial analog or application is highly desirable.

Specifications for such an application are as follows:
• Low cost to manufacture in small quantities: (goal) Less than $10,000 per unit in lots of tens (maximum) Less than $100,000 per unit in lots of one hundred.
• Operating temperature: (goal) >40 deg. C, (minimum) 25 deg. C
• Package size: (goal) < 15 cubic inches, (maximum) 30 cubic inches
• Low time to install: (goal) None, (maximum) Less than 1 day/unit
• Cooling: (goal) none, (possibly) conductively cooled by air-, or water-cooled heat exchanger
• Power Consumption: (goal) none

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

PHASE I: In Phase I of this effort the contractor shall assess the various approaches identified for their specific proposal on Counter DEW Techniques. They will provide a trade analysis on the costs and benefits of these approaches relative to size, weight, efficiency, cooling requirements, production potential and cost. Based upon the findings of the trade study, a detailed design for such a device with performance projections shall be developed. The design must describe the techniques used to mate the proposed system into the weapon and show expectations for performance, as well as the cost impact of the solution when compared to the “all up round production cost” (AURPC) compared to an unimproved weapons system. In general, cost goal increases of less than 2% are encouraged per AURPC in order to enable transition to an acquisition program office.

Trend analysis and projections will be presented against generic commercially available systems whenever possible. However, the technology within this topic is often 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 their statement of work.

PHASE II: In Phase II of this effort the contractor shall build a suitable number of prototype devices to allow for experimentation and demonstration. A demonstration of the developed devices must show that the specified minimum requirements, specifically for spectral and spatial properties, are either met or exceeded. Depending on the application, the effort may make several, or only a few prototypes to prove and test the effectiveness of various techniques used.

In some cases, the development of a material countermeasure or counter-technique may require access to classified information, and therefore may become classified in Phase II. In those cases, an establishment of a "need to know" and a suitable Department of Defense, Contract Security Classification Specification, Form DD254, will be executed. This is not required in every case, but may be required in certain circumstances.

Though Phase II work may become classified, the proposal for Phase II work will be submitted as UNCLASSIFIED only. If the selected Phase II contractor does not have the required certification for classified work, the Navy program office will work with the contractor to facilitate certification of related personnel and facility.

PHASE III: In Phase III, the contractor shall work with the government to conduct a low rate production study on a specific design or designs as of the developed solution set, possibly using representative DEW systems intended to defeat weapons systems at tens of kilometers.

In some cases, the development of a material countermeasure or counter-technique may require access to classified information, and therefore the Phase III effort may become classified. In those cases, an establishment of a "need to know" and a suitable Department of Defense, Contract Security Classification Specification, Form DD254, will be executed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Laser eye safety and HPM protection systems are required for numerous civil and commercial applications including telecommunications. This work is currently performed with eye hazardous laser sources, which force operators to either fly at altitudes that keep the eye hazard to a minimum or use bulky and expensive protection for electronics, such as flight avionics. A compact protection capability for safely working around high energy laser sources or high power microwaves would positively impact this business area.

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3. “Laser Illumination in the Cockpit: prank or terrorism?” Connor, C. W. , Aviation Security International 11, no. 1 (February 2005): 8-12

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5. Jane’s Unconventional Weapons Response Handbook. Sullivan, John P. et al. (See sections on Lasers)

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KEYWORDS: Lasers; High Energy Lasers; HEL; Laser Protection; High Power Microwave; HPM; Directed Energy

N101-088 TITLE: Alternative Energy Systems and High Efficiency Water Purification Systems for Humanitarian Assistance and Disaster Relief Operations, and Expeditionary Operations

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: MARFORPAC POC: Mr. Donn Murakami, 808-477-8909.

OBJECTIVE: Develop a 5 – 50 kWe alternative/renewable energy system and/or an efficient 200 gallons per day (gpd) water purification system capable of being easily transported and made operational by four (4) people within 2 hours. The systems may be individual stand alone systems or a common system.

DESCRIPTION: Develop a power system and a water purification system – separately or combined – that uses an alternative/renewable energy source (e.g., solar, wind, hydro, current, etc.) vice a logistics (petroleum, bio-fuel, blends, etc) fueled energy source. Either a power systems or a water purification system may be proposed. Alternatively, a combined capability system may be proposed. Both systems must be efficient, modularly expandable in the field and capable of being assembled and made operational within a 4 hour period by no more than four (4) people. The power system will produce a minimum of 5kWe expandable to 50kWe at design ratings. Individual power system modules should weigh no more than 80 lbs (including packaging), should integrate packaging with the renewable power source if possible (to avoid loss upon deployment), be ruggedized for transport, and facilitate rapid deployment.

The metrics for the water purification system will be based on a scaled down version of the Marine Corps/Army Lightweight Water Purifier, though there is no requirement for reverse osmosis to be used. The unit must be capable of treating any source water including seawater (to 60,000 ppm TDS), brackish, turbid, and NBC-contaminated sources. The unit should have higher productivity or efficiency for fresh water compared to seawater. The unit should be lightweight weighing less than 1 pound per gallon per day production capacity based on seawater and should ship with <10 cubic foot of volume. The unit should not use more than 6 kW-hr per 200 gallons of product water from seawater. The unit should require minimal technical expertise to operate. Product water should be to EPA National Primary Drinking Water Regulations drinking water standards.

The complete power system or the complete water system, or a complete combination system must be capable of being transported in a standard military vehicle/truck or air-lifted by an H-53 type helicopter.

PHASE I: For the power system, conduct a proof of concept demonstration using selected alternative renewable energy source(s). Establish the conversion efficiency at the device and overall system level. The developer must identify the IEEE, ASTM, NEMA and/or other relevant standards the system is being designed to meet. Develop system schematics with volumetric, weight and cost estimates for a complete system.

For the water purification system, a proof of concept breadboard unit should be constructed that desalinates seawater (35,000 ppm TDS) to less than 500 ppm TDS and in fresh water mode treats source water to 15-minute silt density index values (ASTM D4189-07) of less than 3.0 and turbidity values less than 1.0 NTU while showing a pathway to meet the weight, volume, and energy metrics. Novel approaches or approaches integrated with novel power sources should be developed and tested to a level where the technical feasibility to meet program metrics under a phase II is demonstrated.

PHASE II: For the power system, develop a full scale prototype using the selected energy source(s) and conduct a 168 hour continuous test without a significant failure (one that requires replacement of a major/critical element). Measure the conversion efficiency at the device and overall system level. The power output and power quality must meet the appropriate IEEE standards. Develop detailed system drawings and volumetric, weight and cost estimates for a complete system. Prepare a transport plan with erection/assembly details, and an operational guide.

For the water purification system, a robust prototype unit should be constructed that desalinates seawater (35,000 ppm TDS) to less than 500 ppm TDS and in fresh water mode treats source water to 15-minute silt density index values (ASTM D4189-07) of less than 3.0 and turbidity values less than 1.0 NTU while meeting the weight, volume, and energy metrics. The product water should meet EPA National Primary Drinking Water Regulations with disinfection.

Develop detailed system drawings and volumetric, weight and cost estimates for a complete system. Prepare a transport plan with erection/assembly details, and an operational guide. For a combined system the same demonstrations are required.

PHASE III: The contractor will prepare complete system and user-documentation. It is expected that a successful result will be relied upon to support deployed forces during a joint or international operational exercise to fully demonstrate the capability of the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The energy system and the water purification system are directly applicable to civilian disaster relief efforts and other civilian short term remote location applications.

REFERENCES:
1. EPA National Primary Drinking Water Regulations, (http://www.epa.gov/safewater/contaminants/index.html#listmcl)

2. IEEE Standards (http://www.ieee.org)

KEYWORDS: alternative energy; renewable energy; distributed power systems; water purification;

N101-089 TITLE: <u>Light Weight Coastal Topographic/ Bathymetric Charting System for Naval Unmanned Airborne Vehicles</u>

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PEO C4I/PMW-120 Future MetOc Capabilities

OBJECTIVE: Design and build an autonomous hydrographic charting, terrain and urban area mapping system that can be accommodated within the payload and operational limitations of a Tier II UAV, with equal or better capabilities to the current manned Compact Hydrographic Airborne Rapid Total Survey (CHARTS) system.

DESCRIPTION: The need is to employ new technologies in signal processing chip size and processing power, lidar tranceivers, hyperspectral focal plane arrays and related technologies to reduce size, weight, and power (SWAP) of DoD hydrographic mapping systems. The current aircraft-based precision hydrographic charting, terrain and urban area mapping technologies require manned operation and the payload capacity of a C-12 sized aircraft. Designing a new system that could be carried by a Tier II unmanned aircraft platform in the Navy inventory, such as the Scan Eagle UAS would allow the system to operate in conditions not supportable by the current capability. This will require S&T development to significantly miniaturize the topographic/hydrographic LiDAR, power, navigation, and processing systems. See References below and http://shoals.sam.usace.army.mil/Charts.aspx for technical specifications of the fielded system.

The new system should be capable of collecting hydrographic and topographic data in a single mission with data point ground spacing no larger than 4-meters by 4-meters in a variety of water clarity conditions and bottom types. The ability to interface with organic Tactical Control Stations (TCS) is needed as well as the ability to retrieve and rapidly process collected data post flight or in real-time to the TCS, although these would be requirements for Phase III development or beyond. The hydrographic/topographic system should either provide its own precise navigation and attitude capability or have the ability to utilize organic systems onboard the UAS.

PHASE I: Develop overall system design that includes specification of remote sensing approach and enabling technologies for the required digital terrain elevation and bathymetric retrievals, sensor engineering specification to meet the payload restrictions of the Naval Tier II UAS, and general protocols for operation and environments where the proposed solution will be valid.

PHASE II: Develop and demonstrate a prototype system in a realistic environment to include autonomous operation of the sensor and size/weight/power within payload specifications of expected operational platform. Conduct testing in coastal environments to prove feasibility over extended operating conditions and resulting data retrievals to compare with ground truth survey data. This testing should be compliant with UAS specifications and Interface Control Documents but may be conducted by a contract aircraft or other contractor provided platform.

PHASE III: Transition the technology to scientific use in the atmospheric, oceanographic and environmental monitoring research communities; and operational use by DOD charting and mapping systems such as those deployed by DoN NOP, USACE, and USGS. Prototype system will be retained by ONR.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be used in a broad range of military and civilian survey operations where autonomous systems are necessary or more cost effective – for example, by DoD, USGS, or NGOs in overseas or peacekeeping operations or disaster recovery where air dominance is not completely secured. Nearly 300 projects have been completed with the current system since 1994 including Coastal Navigation, Nautical Charting, Military Rapid Environmental Assessment, Regional Coastal Zone Mapping, Emergency Response/ Disaster Recovery, and Environmental Conservancy.

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2. Guenther, G.C., Lillycrop, W.J. and Banic, J.R. 2002, Future advancements in airborne hydrography, International Hydrographic Review, August 2002, 3:2:67-90.

3. Office of the Secretary of Defense (OSD) 2007. Unmanned Systems Roadmap 2007-2032. Available from: http://www.acq.osd.mil

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KEYWORDS: lidar; hyperspectral; topographic survey; bathymetric survey; airborne autonomous systems

N101-090 TITLE: Error Correction for Innovative ADC

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: PMW-120 for Ship's Signals Exploitation Equipment (SSEE)

OBJECTIVE: The objective of this effort is to determine the performance advantage offered by real-time error correction of superconducting or other novel technology analog to digital converters (ADC).

DESCRIPTION: Error correction has demonstrated the ability to improve the SNR performance of Si ADC by as many as 3 bits. However, this has not yet been attempted in combination with ADC built using superconducting, advanced semiconducting (e.g. InP or InSb), or optical devices. Yet some of these rival the performance of highly mature Si ADC. The goal of this effort is to document what if any performance advantage can be derived by doing error correction on the data emerging from the ADC, essentially providing detailed calibration. (This is very distinct from error correction of waveforms which is done in the demodulation phase of RF receivers. Here correction of the individual values reported to make them better matches to the incident waveform is meant.) It is expected that the simplest version would correct for static calibration errors of, say, a flash ADC resistor ladder. (Vendors are expected to start from an innovative, fast sampling ADC of equivalent performance to a Si ADC or having a definite performance advantage such as ability to directly receive at a carrier frequency of 7.5 GHz or higher.) More complicated blind adaptive versions of error correction may be capable of finding systematic errors associated with specific design flaws or changes in the environment (e.g. temperature swings). Either FPGA or GPU platforms can be used to host the algorithms, though high raw sample rates are strongly preferred.

PHASE I: Finalize the relationship with an ADC vendor named in the proposal, agree on which signal sources to use in the initial testing, obtain either recorded data or the loan of an ADC for testing purposes, and demonstrate the ability of the first algorithm to handle a known (and discussed in the proposal) noise source. (Examples might include resistor ladder relative error or phase errors in a time interleaved ADC.) Generate a quantified argument re: the performance advantage expected to arise in phase 2 from a list of possibly useful, targeted algorithms.

PHASE II: Develop and prove out a more complex array of error correction schemes. Establish a schema for organizing the use of the different algorithms that is responsive to the signal circumstances. (For example, range of composite signal amplitudes, range of slew rates represented, or diversity of BW in signal set.) Determine how to relate the systematics of the error correction applied to the specific residual errors included in the ADC design. Determine how close to 3 bit improvement on a 10 MHz sample the effort ought to be able to produce and how the performance benefit will scale with output BW as the BW emerging from the ADC is widened toward 500 MHz. Estimate the latency and power consumption associated with the error correction and determine how/whether it scales with the performance enhancement achieved.

PHASE III: Finish optimizing and incorporate the error correction package and its mated ADC into an acquisition program product, most likely in the SIGINT realm.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High performance, high sample rate analog to digital converters are especially applicable to wireless base stations where they can be used to handle a greater diversity of signal types and greater throughput of simultaneous signals. The error correction algorithms developed for 1 ADC will presumably be applicable to others. In addition, the techniques may be applicable to error correction as it applies to radiation upset events in conventional Si processors on space vehicles and to the corrections expected to be applied within future quantum computers.

REFERENCES:
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2. http://portal.acm.org/citation.cfm?id=832297.836379

3.http://ieeexplore.ieee.org/Xplore/login.jsp?url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F10432%2F33126%2F01559465.pdf&authDecision=-203

4. http://www.analogzone.com/acqt0515.pdf

KEYWORDS: error correction; blind & adaptive; analog to digital converters; error sensing

N101-091 TITLE: Automated Shipboard Build-up of Customized Pallet Loads

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: The Operational Logistics Integration Program Office

OBJECTIVE: Develop an automated system to enable the rapid shipboard build-up of customized pallet loads at the rate of 72 pallet loads per day. These precisely-tailored packages of equipment and supplies are needed to support soldiers ashore.

DESCRIPTION: Currently, sailors manually assemble pallets of supplies on board a ship for soldiers ashore. They break apart existing pallet loads in order to build-up outgoing pallet loads that contain the precise mix of supplies needed. For example, an outgoing pallet load might require a certain number of bullets, cans of soda, bags of rice, and boxes of cereal. These items must be arranged optimally on the destination pallet so that the supplies are not damaged. One sailor is only able to build 15 such customized pallet loads per day, far short of the 72 pallet loads per day needed to properly equip the soldiers ashore. This effort will develop the necessary technology to automate and speed-up the process of constructing customized pallet loads. The resulting technology will need to detect the relevant packing properties (fragility, orientation, size and shape, etc.) of each piece of source material so as to optimize packing of the destination pallet load. Performance goals are to reduce the time to retrieve, assemble, and load pallets by 60% (objective), 40% (minimum). Also, to reduce inventory errors by 75% (objective), 50% (minimum). Additionally, to reduce required logistics personnel by 70% (objective), 40% (minimum). An example of this capability could be a fine-dexterity robotic manipulator that could selectively pick source items from incoming pallets, identify their relevant packing characteristics, and pack the items optimally in a destination pallet. The system must be capable of installation onto existing or future ships, operate within the limits of shipboard power generation and distribution systems, and operate safely in a marine environment. Note that proposers are not meant to be bound by the technologies described here, but are encouraged to provide their own solutions.

PHASE I: Develop a concept design for a system to automatically build-up customized pallet loads.

PHASE II: Conduct testing to prove-out the feasibility of the technologies proposed in Phase I through system or sub-system component demonstrations. Modeling and simulation may be acceptable in some cases.

PHASE III: Transition to a functional product. This technology could also be used in a broad range of non-military and commercial applications where rapid assembly of customized shipments can reduce costs, save time, and decrease the overall environmental impact.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are applications for the commercial freight industry where the need exists to break apart incoming shipments in order to assemble custom configurations for outgoing shipments. There are additional applications for distribution centers where automation for de-palletizing and re-palletizing product would save time and money. Other applications relate to the bundling of cargo in Unit Load Devices (ULDs) on commercial aircraft.

REFERENCES:
1. Cargo Specialists' Handbook FM-55-17

2. Seabasing Logistics Enabling Concept from the Office of the Chief of Naval Operations, December 2006

3. Seabasing Joint Integrating Concept, 1 August 2005

4. Photos of Built Up Pallets (from TPOC; posted 12/09/09).

KEYWORDS: Task-reduction; workload-reduction; demand-tailored; assembly; reconfigure, sustainment

N101-092 TITLE: <u>Cost-Effective PiezoCrystal Transducer Assembly Technologies</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: PMS 415 Undersea Defensive Warfare Systems: Next Generation Countermeasure

OBJECTIVE: Devise and demonstrate innovative materials processing methods for the cost-effective fabrication of relaxor piezoelectric single crystals into complex SONAR transducer assemblies. Candidate technologies in the fabrication of PiezoCrystal transducers include, but are not limited to: forming the as-grown crystalline material into the desired shapes, electroding the crystal, attaching electrical leads, poling the crystal, bonding crystal to crystal, bonding crystal to metals, bonding crystal to insulators, and bonding crystal to polymers.

DESCRIPTION: More than a decade ago a class of materials (relaxor piezoelectric single crystals) came to the fore whose electromechanical transduction properties greatly exceeded those of legacy materials (primarily, piezoelectric ceramics): electromechanical coupling greater than 90% (versus 70-75%) and strain levels greater than 1% (versus, less than 0.1%) [References 1 and 2]. Based on these materials acoustic transducers have been demonstrated with dramatically enhanced performance over what is achievable with the legacy technology --- for example, increased bandwidth (>x2), source level (+12 dB), sensitivity (+12 dB), compactness (>x3) and lightness (>x2) [Reference 3]. These device performance gains (totaling one to two orders of magnitude) have yielded gains, at the system level, of factors of two to six [Reference 4]. Indeed, the PiezoCrystal transducer technology makes possible some systems that simply would not be practical with the legacy technology. Navy SONAR systems have already completed the technology development and demonstration phase and are poised to enter the system development and demonstration as part of the acquisition process. To date, these PiezoCrystal devices have been fabricated by adapting, at the gallop, legacy transducer fabrication methods. This topic aims to devise and validate innovative assembly fabrication methods specifically tailored for the relaxor piezoelectric single crystals.

PHASE I: Select one or two candidate fabrication technologies and devise innovative methods specifically for relaxor piezoelectric single crystals. Demonstrate the efficacy of the new methods by building and testing a candidate SONAR transducer. It would be a big plus if the candidate transducer demonstrated was for a real Navy SONAR system.

PHASE II: Develop a full spectrum of piezocrystal transducer fabrication technologies and demonstrate their efficacy by building and testing one or more piezocrystal transducers for insertion into a SONAR system in development or for upgrading a SONAR system already in production.

PHASE III: The technologies developed by this research will be used to fabricate development and production piezocrystal transducers for a broad spectrum of Navy SONAR systems: countermeasures, mine hunting, torpedoes, acoustic modems, towed arrays, moored arrays, sonobuoys, and the like.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed for defense transducers will be immediately applicable to transducers in civilian SONAR systems. Moreover, these assembly fabrication technologies will be readily transferred to making electromechanical sensors and actuators for a broad spectrum of civilian applications ranging from hydraulic servo valves, through vibration energy harvesters, to robotic manipulators.

REFERENCES:
1. S.E. Park and T.R. Shrout, “Ultrahigh Strain and Piezoelectric Behavior in Relaxor based Ferroelectric Single Crystals, “ J. Appl. Phys., 82[4], 1804-1881 (1997).

2. S.E. Park and T.R. Shrout, “Characteristics of Relaxor-Based Piezoelectric Single Crystals for Ultrasonic Transducers,” IEEE Trans. On Ultrasonic Ferroelectrics and Frequency Control, Vol. 44, No. 5, 1140-1147 (1997).

3. J. M. Powers, M. B. Moffett, and F. Nussbaum, "Single Crystal Naval Transducer Development," Proceedings of the IEEE International Symposium on the Applications of Ferroelectrics, 351-354 (2000).

4. T. C. Montgomery, R. J. Meyer, and E. M. Bienert, "Broadband Transduction Implementation and System Impact," Oceans 2007, 1-5 (2007).

KEYWORDS: piezoelectric single crystals; SONAR transducers; fabrication technologies; electroding; bonding; poling

N101-093 TITLE: Energy Harvesting from Thermal and Vibration Loads due to High Temperature, High Speed Impinging Jets

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO (Ships)

OBJECTIVE: Perform laboratory scale experimental study to understand and characterize the vibrational and thermal effects of impinging jets on surfaces. Develop computational tools and models to evaluate thermoelectric and piezoelectric materials for absorbing this wasted energy and to convert to useful power. Provide information to utilize this methodologies to simulated carrier deck conditions.

DESCRIPTION: Due to the conditions created by the takeoff and landing of various fixed wing and rotor aircraft, the operational environment on an aircraft carrier flight deck is very harsh, both for the personnel and the structural components of the deck itself. For example, the high-temperature, high velocity jet exhaust from the F/A-18E/F during takeoff and landing produces very high noise levels that may compromise the performance and safety of the flight crew personnel operating in proximity to the aircraft. These high noise levels also propagate through the flight deck, thus making the environment hostile even for personnel below the deck. The problems associated with jet impingement will be exacerbated with the introduction of the F-35B, which is a vertical takeoff and landing (VTOL) aircraft. The near-vertical impingement of the lift jets results in a number of adverse ground effects, including ground/surface erosion of the landing surface due to the high-temperature, highly unsteady impinging jets; significantly higher noise levels; enhanced unsteady heat transfer through the deck surface, and vibration. These conditions pose an additional risk to the crew operating near such aircraft and under the deck, and also affect the integrity of the carrier flight deck. This SBIR topic addresses the thermal and vibration effects, to damp/absorb them and to convent to useful energy, as well as to reduce the noise. Accomplishments from this SBIR effort will complement to other noise reduction efforts to harvest the wasted energy in the unsteady thermal load and vibrations. This in turn helps to reduce cost of operation.

PHASE I: Experimental and/or numerical study at laboratory scale to understand the thermal load fluctuations and vibration due to impingement of unsteady hot jet on a flat surface. Develop numerical models and codes to predict and evaluate the various parameters involved.

PHASE II: Evaluate properties of thermoelectric, piezoelectric of similar materials for heat and vibrations absorption. Develop experimental rig to examine effectiveness of noise isolation, and vibration and thermal energy utilization from hot jet impingement on walls (double).

PHASE III: Under simulated conditions of engine exhaust jet impinging deck, conduct parametric study, develop user-friendly predictive tools, and optimize isolation and energy management for transition to real deck environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The methodologies developed in this SBIR program will generally be applicable to noise reduction and energy absorption from walls on engine rooms in commercial ships. Any energy harvesting technology developed will have a wide range of commercial applications in areas where vibrations and thermal loading are present.

REFERENCES:
1. Krothapalli, A., "High-Speed Jet Noise Suppression: A Review and an Extension", Advances in Combustion and Noise Control, pages 261-286, Cranfield University Press, 2005

2. Maillard, J.P, Fuller, C. “Active Control of Sound Radiation from Cylinders with Piezoelectric Actuators and Structural Acoustic Sensing”, J. Sound Vibration, 1997

KEYWORDS: High Speed Jet noise, Flow-structure interaction, piezoelectric materials, pyroelectric materials, vibration, thermal loads, energy conversion, energy harvesting

N101-094 TITLE: Prevention of Laparoscopic Surgical Skill Attrition

TECHNOLOGY AREAS: Biomedical, Human Systems

ACQUISITION PROGRAM: Capable manpower

OBJECTIVE: Provide to U.S. Military new capabilities to support minimally invasive surgical (MIS) Laparoscopic surgery procedures, reducing the need for extensive retraining and providing new validation methodologies.

Provide US military health care providers and their Interagency partners with objective metrics and measurement techniques to conduct validation for immersive and simulate training environments (e.g., virtual).and with new training strategies that will prevent decay of these highly perishable skills.

DESCRIPTION: Minimally invasive surgery (MIS) has many benefits over traditional types of surgery. (MIS) results in less pain, less scarring, and shorter recovery times for patients, as well as significantly reduced costs. The skills required for laparoscopic surgery vary greatly from those involved in traditional surgical methods, and thus require extensive specialized training. However, research has indicated that MIS is associated with higher rates of complications than traditional surgery. A few studies have demonstrated that virtual reality training translates to improved laparoscopic skills in the operating room [1] [2] [3] [4]. However, the primary methods of assessment and evaluation are inherently subjective. For example, time to completion is a poor metric for the objective assessment of laparoscopic task performance [5], and that when untrained subjects are learning a laparoscopic manipulative task, measurement of time alone fails to account for the more protracted learning curve for accuracy; thus, devices and training programs that fail to consider objective assessments of accuracy may overestimate laparoscopic proficiency [6].

Over the past decade, attempts have been made to establish standards for MIS training and evaluation. Using virtual reality simulators to determine what constitutes surgical skill proficiency, and how it is to be objectively assessed within training [7], further validation of the specific metrics used is needed. These metrics must demonstrate reliability, validity, practicality, and consistency with measures of high quality surgery in the operating room in order to provide the basis for proficiency-based learning programs [8].

Moreover, little is known about the durability of acquired surgical skills. Some studies have shown the retention of laparoscopic surgical skills to be high over periods of up to 11 months, with practice impacting the rate of decay [9] [10] [11]. However, these studies have relied primarily on subjective simulator-based metrics for assessment, which have been shown to be unrelated to transferring skills over extended periods of time [12]. A successful candidate proposal would develop a conceptual model and objective measures to reliably assess surgical skill acquisition, proficiency, and decay/retention.

PHASE I: Execute a research program that includes the development of a skill decay model for (MIS) that identifies those skills that are the most perishable and their rate of decay. Identify objective methods and measures to reliably assess these skills. The primary research question is, are their differences in the skill decay rate for different types of skills (cognitive vs. psychomotor skills)? Are their individual differences across the continuum of novice to expert surgeons in the rate and types of skill decay?

PHASE II: Develop a simulation based prototype training module, refresher training, based on the research results of Phase1. Provide proof-of-concept demonstration of training module and reliability and validity estimates of measures of skills developed in Phase 1.The results of this project could also be used to develop initial simulation based training to train MIS skills that are resistant to decay. The prototype should be open architecture and open sources and scalable to meet future needs.

PHASE III: Provide US military health care providers and their Interagency partners with objective metrics and measurement techniques to conduct validation for immersive and simulate training environments (e.g., virtual).and with new training strategies that will prevent decay of these highly perishable skills.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Has USG-wide and possibly Multinational and International application (United Nations, NATO).

REFERENCES:
1. James C. Rosser, MD; Ludie E. Rosser; Raghu S. Savalgi. (1997). Skill Acquisition and Assessment for Laparoscopic Surgery. Arch Surg. 132(2), 200-204.

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KEYWORDS: skill decay, surgical skills, expert , novices

N101-095 TITLE: <u>Distributed Sensor Network for Structural Health Monitoring of Ships</u>

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

OBJECTIVE: To develop a distributed network of sensors for load monitoring of ship structures. The target attributes of the system are outlined below, but in general the system should be reliable and durable in a sea environment, capable of monitoring a minimum span of 400 ft, the sensors should have a small footprint so as to be cost effective and non-intrusive, with good dynamic range and sensitive, reconfigurable, adaptive and scalable up to 500 sensors, with good frequency response. Other attributes include EMI resistance and have minimal wiring and maintenance requirements (no batteries, no switches).

DESCRIPTION: A highly reliable, non-intrusive system for monitoring loads in Naval structures (ships and submarines) as well as next generation weapon systems is critically needed. Strain monitoring is a proven method for assessing the performance of a structure and for determining the remaining fatigue life left on the structure. However, present strain monitoring systems suffer from various limitations. The sensors need two or four wire leads to pick up the signal, the sensors and wire leads have to be heavily shielded to minimize EMI, each sensor needs a pre-amplifier and signal conditioner nearby, and two more wire leads are required for each amplifier as well as powering. These limitations make current technologies intrusive, cumbersome, heavy, susceptible to EMI, overly complicated and with many failure points. New and promising technologies are being sought that might address these issues. Techniques that use fiber optic sensors or wireless MEMS sensor nodes are two examples that could offer the opportunity to overcome all these limitations. Overall objectives for this program are simplicity, reliability, scalability and affordability.

PHASE I: During the phase I the contractor will demonstrate the ability to monitor strains in a loaded aluminum or steel panel by using the advanced distributed sensor concept. The system will have a minimum of 50 sensors and monitor a large aluminum or steel cantilever with a proof mass producing a 10 Hz resonance. The software development component for the Phase I will be limited to data acquisition and display of the strain data in a pictorial manner. Some of the target system parameters are: system reliability (this includes the sensor, the signal and the attachment method = 10 years in a sea environment); small footprint size (= 1 cm2), weight (= 1 gram), and cost (cents); large dynamic range (=± 5,000 microstrain); with good sensitive (1 microstrain or better); good frequency response (up top a 200 Hz); large range (around 400 feet); minimum maintenance requirements (no batteries, no switches).

PHASE II: During the Phase II the contractor will develop all the necessary components for a standalone unit capable of monitoring 500 sensors for loads monitoring. The system will be dynamically reconfigurable, adaptive, have a small foot print and be capable of self diagnosing. By dynamically reconfigurable it is meant that the system should be able to reconfigure itself so as to monitor a fraction of the 500 sensors with higher fidelity when appropriate. By adaptive it is meant that as the region of interest shifts from one location to another, the system should be capable of quickly adapting to that new circumstance. By stand alone it is meant that the system will collect, analyze, compress and store the entire strain state and strain history of the ship hull for a specified period of time. By self diagnosing it is meant that the system can identify those sensors that are providing faulty information so that they can be removed. One of the main components of this effort during the Phase II will be software development. The software should be able to adjust the sampling rates in response to the structural behavior, compress or reduce the massive amounts of data to a meaningful set of parameters, be able to reconstruct the strain history from that set, store and display the data.

PHASE III: A strain monitoring system of this nature could be installed in many DoD platforms (including destroyers, cruiser, amphibious ships, submarines, fighter, patrol and transport aircraft) which have key structural components (such as pressurized bulkheads, rudders, propellers, superstructures and wing attachment point) that require strain or loads monitoring. Significant cost savings could be achieved by the installation of such a system and therefore, performing maintenance at longer time intervals or only when the system indicates that it is required. The contractor, in collaboration with the Navy monitoring team, will seek a potential military application and/or demonstration during Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial shipping industry would benefit significantly from a system of this nature as well. The same problems that we experience in our Naval platforms (ships, subs and aircraft) are experienced by equivalent commercial platforms. For example, wide spread area fatigue damage has been determined to be a major source of problem for commercial aviation.

REFERENCES:
1. G. Wang, K. Pran, G. Sagvolden, G. B. Havsgard, A. E. Jensen, G. A. Johnson and S. T. Vohra, "Ship hull structure monitoring using fiber optic sensors", Smart. Mater. Struct, 10:472-478 (2001).

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KEYWORDS: Strain Monitoring, Load Monitoring, Condition based maintenance (CBM), Structural Health Monitoring (SHM), MEMS, Optical Fibers, Bragg Gratings, Wireless

N101-096 TITLE: Non-Inductive Actuation Mechanisms to Reduce Interference with Magnetometer-Based Navigation

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: FNC: EMW FY11-01 – Precision Urban Mortar Attack (PUMA)

OBJECTIVE: Demonstrate an inexpensive, non-inductive actuation mechanism that can be used in a canard actuation system (CAS) without adding noise or bias to the measurements of onboard magnetometers during guidance and fuzing operations of miniaturized precision munitions.

DESCRIPTION: Magnetometers are widely used as roll orientation and roll rate sensors for navigation systems. They are widely used in navigation because the earth's magnetic field does not change over the wide range of operating conditions (including GPS jamming) that a guided munition would experience, and can provide an accurate roll orientation reference, and roll rate data. However, conventional canard and control surface actuators are inductive in nature (DC brushless motors, solenoids) and often will corrupt the output signal of the magnetometer, thus inducing error into the navigation solution. Traditionally these devices are either shielded or moved far away from the magnetometer to mitigate the effects. With the demand for smaller and smaller precision munitions (81mm, 60mm) it becomes infeasible to move the actuators far enough away from the sensors, and shielding takes up precious volume that is required for other components. Other actuation methods such as pneumatic and gas reservoir are infeasible due to the volume requirements for the reservoir.

PHASE I: Develop actuator design that includes specification of technology/phenomenology employed to facilitate non-interference, and provide estimates of SWAP and output.

PHASE II: Develop and demonstrate a prototype actuator in a laboratory environment. Conduct testing in a controlled magnetic environment to characterize non-interference performance. Conduct lab testing to show performance of adequate mechanical output for guided mortar applications.

PHASE III: This technology is expected to transition to the PUMA FNC and, if successful, may become an integral part of mortar guidance kits in development by the U.S. Marine Corps and U.S. Army.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These actuators could be used in a variety of military and civilian automation, robotics, motion control, and navigation systems where it is advantageous to package magnetometers next to control actuators.

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KEYWORDS: actuators, magnetometer, sensors, precision, munitions, navigation, miniaturization, non-inductive

N101-097 TITLE: Innovative Material Design and Manufacturing Development for a Lightweight, Low-Cost, Highly Survivable Drive Shaft

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-261; CH-53K Heavy Lift; ACAT I

OBJECTIVE: Develop an innovative material solution (such as composites), design, and manufacturing process for a driveshaft that demonstrates high damage tolerance; that will be proven superior to a legacy shaft in terms of total affordability, weight, and durability for use in demanding aircraft applications.

DESCRIPTION: The primary application for this technology is to replace current baseline high speed drive shafts with a dynamically compatible, light weight, and ballistically tolerant alternative of equivalent strength and stiffness. Selected bidders are encouraged to collaborate with an original equipment manufacturer (OEM) to facilitate transition of proposed drive shaft design.

The proposed research would investigate low-cost alternative material constructions that offer improved damage tolerance, durability, and structural efficiency. The new drive system shall enable reduced acquisition and operational costs, with improved levels of maintainability and reliability. An important perquisite with the development of potentially experimental material designs is the robust manufacturing technique that realizes the vendor's product. The proposing bidders must be able to demonstrate competence in the quality of their construction and the effectiveness of their facilities—e.g. factory floors, clean rooms, labs—especially if the design calls for an equally innovative manufacturing process.

The new shaft assembly shall possess highly controlled dimensional tolerances typical of dynamic components and also be designed with the foresight of future retrofit, and therefore minimal deviation from current baseline geometry is required. This will ensure ease of implementation into current production aircraft with minimal redesign cost with respect to integration with surrounding structure. Coefficient of thermal expansion (CTE) compatibility with the airframe, bearings, and attachment hardware is required to minimize thrust loads and simplify retrofit. Furthermore, the proposed design shall ensure drive shaft bearing durability.

It is recommended that bidders work with an OEM to ensure that the new driveshaft design integrate with the metallic couplings existing in the baseline in order to guarantee torque transmission effectiveness without strength or durability loss and meet fail-safe requirements.
Design must also demonstrate safe operation in severe thermal and dusty environments and dimensional stability along the length of the driveshaft to minimize induced loads on bearing and attachment hardware. Suppliers should demonstrate optimal configurations that ensure no thermal load build-up or stress concentrations.

Prior programs were successful (Ref. 2) in realizing the development of a composite driveshaft system. This system applied innovative architecture and Resin Transfer Molding (RTM) methods using untoughened epoxy in order to maintain precise control over the strict dimension constraints. However these concepts were not able to demonstrate adequate low velocity impact damage (LVID) and ballistic damage tolerance.

PHASE I: Develop a manufacturing approach and a conceptual design of the driveshaft to a sufficient level of fidelity to serve as basis for initial structural analysis. Demonstrate the low-cost feasibility of proposed design through a series of standard ASTM static and fatigue coupons tests to show equivalent strength and damage tolerance with reduced weight. Define and develop an approach for testing the proposed design against a current baseline design.

PHASE II: Generate preliminary structural allowable data for the proposed material construction by building risk reduction sub-elements and test articles representative of the proposed drive shaft design and conduct teardown analyses to evaluate laminate quality per plan laid out in Phase I. The proposed construction would be validated by building short, actual diameter specimens which would be subjected to static and fatigue tests, dynamic tests, and ballistic tests. It is recommended that these results be compared to existing baseline test results from an OEM to validate equivalent structural capability and dynamic response. Preliminary shaft design shall reflect refined mechanical performance and physical attributes.

PHASE III: Mature the proposed technologies to a Technology Readiness Level (TRL) 6 for transition to an actual production platform. Qualify final design of the drive shafts by mechanically testing a series of full scale test articles, including static deflection, torsion testing, pristine and defect fatigue testing, and ballistic tolerance testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Alternative material processes for driveshaft applications have the potential to benefit the military, public, and private sectors. For example, the utilization of composites to replace metal in structure and dynamic components is becoming more popular as the private and military industries focus on improved affordability and durability. Composites offer significant weight reduction and tailored strength properties as opposed to the more traditionally used metals such as aluminum and titanium. They also offer corrosion resistance that extend the operating lifecycle and reduce maintenance and repair costs. This effort, if successful, would be valuable to any high-cycle, torque-bearing, fatigue-resistant shaft application. Alternate material designs for dynamic components can be applied to the aircraft, automotive, as well as automobile industries. Cylindrical shafts utilized in oil and gas exploration rigs at sea could also benefit. This technology could also be implemented in wind turbines used in the energy generation industry.

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KEYWORDS: Ballistic Damage Tolerance; Driveshaft; Advanced Composites; Survivability; Weight Reduction; Affordability

N101-098 TITLE: Skin Friction Measurement Technology for Underwater Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Battlespace, Nuclear Technology

OBJECTIVE: Develop a self-contained skin-friction measurement gauge.

DESCRIPTION: For design, the resistance is a key component in arriving at a viable propulsion system. For example, the friction drag of ships can, at least in principle, be reduced by the use of some form of lubrication at the hull-water interface. Efforts to explore that possibility are hindered by, inter alia, the lack of a means of making direct measurements of friction drag at points on the hull's surface. The objective here is to provide a means to design a gauge that will remedy this deficiency. The shear stress device should be flush with the hull.

PHASE I: Proof of concept demonstration with variations in Reynolds numbers (as high as 1 million) in a water channel/tunnel for a near-wall turbulence measurement system. For the shear-stress device, the contractor is expected to devise an instrument, and to produce a quantitative analytic description of its performance characteristics, that can be implemented in the form of an insert whose outer surface is flush with the hull and is of approximate dimensions 25 mm in length and 12 mm in width. It must be watertight, and able to withstand pressures of as much as 10 atmospheres. There must be no moving parts except for the strain needed to produce a change in the physical property used to effect the sensing. It is expected that the accuracy would be ± 1% or better and that the output would be a digitized sampled data stream.

PHASE II: For near-wall measurements, the contractor will develop and demonstrate the turbulence measurement system at high Reynolds numbers (10 million) on a flat plate in a water tunnel/channel and compare results with analytical theory of turbulence, providing mean and unsteady velocities to within 2-5 microns of the surface. For the shear-stress device, the contractor is expected to construct a prototype and demonstrate its properties in a (small) water tunnel.

PHASE III: For the near-wall measurement system, the contractor will prepare complete system and user-documentation. For the shear-stress device, it is expected that a successful result will be implemented in a large-scale high-speed measurement program aimed at fully characterizing the merits of various techniques of friction drag reduction.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Resistance measurement systems are useful to both air and underwater application communities. This system would provide the unique capability for the commercial and military aircraft, submarine, and ship industries.

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KEYWORDS: turbulence; hydromechanics; underwater measurements; diagnostics; skin-friction; shear stress.

N101-099 TITLE: Spectrum Agile Network Distributed Subcarrier Allocation

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: JPEO JTRS _ network Enterprise Domain - ACAT I

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Define candidate space-time-frequency distributed algorithms and protocols for the physical, MAC, and network layers in a network for manipulating the spectra of OFDM wireless networks nodes in response to degradations observed geographically within the network and within its spectrum. The result will be agile subcarrier allocation strategies for improving mobile military wireless mobile ad-hoc OFDM performance in response to local time-varying spectrum disturbances.

DESCRIPTION: Military wireless networks such as WNW-OFDM need to be able to respond and appropriately adapt to a dynamic electromagnetic environment. The OFDM Mode offers the potential to modify subcarrier allocations in response to environmental challenges given the proper protocols for distributing the responses, which lets the network adapt in a stable fashion. Commercial wireless OFDM cellular networks with fixed infrastructure base stations, towers, cell size, frequency, etc., have an advantage over military networks without fixed infrastructure of a strong central control and the potential to distribute any desired spectrum changes, but do not generally offer this possibility since it would result in changes and degradations to the user interface. Indeed commercial OFDM standards such as IEEE 802.16 cover a wide variety of anticipated commercial users from low data rate voice users to high rate data and video users with vastly differing assigned bandwidths and some preliminary work has addressed mobility and non-contiguous OFDM. IEEE standards continues to develop and incorporate new protocols addressing cognitive radio standards, non-contiguous subcarrier usage, increasing ground mobility and less infra-structure.(e.g., 802.22). However the problem of distributed network control specifically for decentralized geographically dispersed (military) networks continues to be an area that is not well known with known papers only looking at non-applicable solutions such as using GSM (2).

When perfected, spectrum sensing and dynamic spectrum access technologies (see for example references 3, 4, 5, and 6) are expected to be significant enablers of commercial and military wireless networks. The research requested here is intended to look at how subcarrier arrangement strategies can solve electromagnetic problems, and then look at how that strategy/algorithm can be shared and distributed in a non-centralized network.

PHASE I:

1) Establish a state-of-art baseline in subcarrier allocation and net control technology, referring to the 802.22, 802.16xx standards as a minimum.
2) Synthesize candidate dynamic subcarrier allocation strategies and algorithms for OFDM based wireless WNW networks experiencing a variety of possible link conditions including geographically localized narrowband/partial band interference, time varying channels with frequency selective fading, strong neighbor interference and shadowing. The solutions should consist of cross layer subcarrier allocation in the SiS, MDL, MI, & Network layers as well as communicating with neighboring nodes and maintaining network stability.
3) Test/evaluate and rank the candidates in terms of performance benefit, ease of implementation and compatibility with WNW-OFDM architecture.
4) Generate a technology insertion plan for insertion of the winner candidates into WNW.

PHASE II: Develop, demonstrate and validate Phase I selected candidate algorithms and protocols. Revisit the Technology Insertion Plan from Phase I and update it to reflect the current version of WNW. Build a test environment to demonstrate the recommended solutions including their network behavior for stressing environments appropriate to exercise the solutions. Update the net convergence and stability properties of the algorithms based on testing if necessary.

PHASE III: Transition the implementation to the JTRS software environment, inset into WNW, and perform development tests. The software generated in this project is subject to NSA approval prior to incorporation into a JTRS radio, which will have national security requirements and impacts to the vendor. Phase III will include the necessary Information Assurance features for this approval. Phase III will also incorporate JTRS APIs as an application software package for JTRS sets. In addition, the software generated in this project is planned to be incorporated into the JTRS Enterprise Business model, which allows JTRS vendors to utilize common software.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: OFDM and its variants (OFDMA, SOFDMA, etc) is used by both military and commercial wireless systems. The techniques developed as part of this SBIR will be directly applicable to improving the performance and affordability of commercial mobile networks.

REFERENCES:
1. IEEE Standard 802.16e-2005

2. Implementation of a Low Cost Wireless Distributed Control System using GSM Network
Ganegedara, K.M.T.N.; Jayalath, J.A.R.C.; Kumara, K.M.K.; Pandithage, D.N.U.; Samaranayake, B.G.L.T.; Ekanayake, E.M.N.; Alahakoon, A.M.U.S.K.; Industrial and Information Systems, 2008. ICIIS 2008. IEEE Region 10 and the Third international Conference on 8-10 Dec. 2008 Page(s):1 - 6

3. Ekram Hossain and Vuay Bhargava, "Cognitive Wireless Communication Networks", Springer Verlag, 2007

4. Rakesh Rajbanshi, Wyglinski, A.M, Minden, G.J.,Subcarrier Power Adjustment Technique for Peak to Average Power Ratio Reduction of OFDM Systems, MILCOM 2006, 23-25 Oct, pp 1-6.

5. A channel estimation method for NC-OFDM systems in cognitive radio context Shichang hang; Jun Wang; Shaoqian Li; Communication Systems, 2008. ICCS 2008. 11th IEEE Singapore International Conference on 19-21 Nov. 2008 Page(s):208 - 212 6

6. Robust End-to-End QoS Maintenance in Non-Contiguous OFDM Based Cognitive Radios
Mwangoka, J.W.; Ben Letaief, K.; Zhigang Cao; Communications, 2008. ICC '08. IEEE International Conference on 19-23 May 2008 Page(s):2905 - 2909

KEYWORDS: OFDM, wireless, distributed, JTRS-WNW, MANET, dynamic subcarrier allocation, cognitive radio

N101-100 TITLE: Multi-Source Imagery and Geopositional Exploitation (MSIGE)

TECHNOLOGY AREAS: Battlespace

ACQUISITION PROGRAM: Distributed Common Ground System - Navy (DCGS-N) ACAT I

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Previous research in improving multi-source imagery and geopositional exploitation has shown that there are inaccuracies in providing a timely fused battlespace picture in a military environment. The objective of this topic is to provide additional research in improving Intelligence Surveillance and Reconnaissance (ISR) support for Time Sensitive Targeting (TST) by correlating geopositional data with video imagery in real time, within seconds vice minutes or hours. Correlation of the imagery and geopositional data and algorithms will accelerate F2T2EA (Find, Fix, Track, Target, Engage, and Assess) operations by providing integrated multi-source data and visualization to pinpoint, verify, and monitor military targets for engagement and assessment.

DESCRIPTION: Irregular battlespace environment threats have few tactically relevant signatures for remote sensing and prosecution. Precision emitter geolocation, validated with audio identification, has become an important tool for finding and fixing military threats. Geopositional intercepts may be too infrequent for tracking, and must be confirmed with realtime imagery for targeting. This topic will research the combining of the imagery and geopositional find, fix, track and target elements to improve real time support for the battlespace commander. Current research in imagery and geolocation correlation falls short because it could take hours or days in providing a realtime fused battlespace picture.

The Navy seeks an innovative and creative approach in providing a multi-source imagery and geopositional solution that can rapidly transition to operational platforms and Programs of Record (POR) within seconds vice hours or days. Transition of the proposed approach requires software to be based on a loosely-coupled Service Oriented Architecture (SOA) compatible with modern real time web applications. The proposed solution must be able to function effectively in all forms of tactical data communication environments where sensor platforms are connected to each other and to disadvantaged data communications networks (low throughput, dropouts, and security constraints).

PHASE I: Develop algorithms, design software services, and/or design multi-source imagery and geopositional sensor payload architectures to accomplish the following:

- Collect and/or ingest geopositional data.
- Collect and/or ingest Full Motion Video (FMV) imagery.
- Combine geopositional and FMV data.
- Allow the operator to select points in the image data and compute the position of those points.
- Describe how the software design supports integration with emerging modern Service Oriented Architectures (SOA).
- Describe how the solution's concept of operations (CONOP) supports military battlespace and tactical environment operations.

PHASE II: Develop and demonstrate algorithm prototype software services and/or sensors based on the design work performed in Phase I. Demonstrate these services in a laboratory or field test environment. Show how imagery and geopositional correlated targeting can improve realtime operator productivity in a simulated battlespace environment.

PHASE III: Use the technologies developed in Phase II to refine and transition the software services and/or sensor into a Navy ISR/IO Program of Record (POR). Demonstrate the capabilities at a Sea Trial event to support Military Utility Assessment (MUA) for Navy operations.

Private Sector Commercial Potential/Dual Use Applications: Department of Homeland Security (DHS), US Coast Guard, law enforcement, and other civilian agencies that use sensor networks for tracking mobile targets in dynamic threat environments would immediately benefit from imagery geopositional targeting.

REFERENCES:

1. Website reference - Data Schemas for Net-Centric Situational Awareness, Dino Konstantopoulos, The MITRE Corporation: www.dodccrp.org/events/2006_CCRTS/html/papers/073.pdf.

2. Website reference - Georegistration of Remotely Sensed Imagery, Stuart Ness, Dept of Computer Science and Engineering, University of Minnesota: www-users.cs.umn.edu/~cbraxmei/hw/E3_G07_SN.pdf

3. Website reference - Geotagging, Wikipedia: http://en.wikipedia.org/wiki/Geotagging

KEYWORDS: battlespace environment, video, imagery, geoposition, networks, software service oriented architecture

N101-101 TITLE: <u>Densely-Packed Target Data Fusion for Naval Mission-level Simulation Systems</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: Assessments, Simulation-Based Acquisition

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: To develop a framework and technique for enhancing DON mission-level Modeling and Simulation (M&S) to address Detection and Data Fusion (DDF) under dense target scenarios that include hostile, friendly, and neutral forces (i.e. targets of unknown affiliation/allegiance), defining and parameterizing classes of such scenarios and resulting in metrics for optimizing the decision process that point to clear strategic or tactical Courses Of Action (COAs).

DESCRIPTION: Data Fusion is a complex research area, as evidenced for example in Ref [1], which discusses the various levels of data fusion set forth by the Joint Directors of Laboratories of the DOD:

Level 1 - Object Refinement

Level 2 - Situation Refinement

Level 3 - Threat Refinement

Level 4 - Process Refinement

[1] also documents difficulties in translating these levels into DOD DDF system requirements. Applications of data fusion complexities abound in many fields involving human and biological perception [2-4].

This solicitation seeks new concepts in achieving data fusion and in the M&S thereof. Current capabilities within DON mission-level simulators are

1) subject, under densely-packed target scenarios, to ambiguities in track correlation that are difficult to resolve,

2) not adequate for efficient DDF that can subsequently enable robust determination of COAs,
3) not adequate for evaluation of such COAs in M&S as an integral part of acquisition.

This solicitation pertains to the following specific data fusion research areas in multi-INTelligence (multi-INT) collection:

1) all-source fusion
2) anomaly detection,
3) ambiguity resolution through logic (a Fusion, Optimization, and Exploitation (FOX) technology)
4) graphical situational awareness,
5) determination of best Course Of Action (COA) based on information available, and
6) a determination of when additional sensor platforms or resources must be assigned to a region;

An example of a complex problem in MDA and MIO is the case in which the Area of Uncertainty (AOU) and/or field of view of a given sensor include two or more targets of unknown allegiance (a case appropriately described as 'densely-packed targets'). A worse case may be one in which targets are so densely packed that a given sensor is only capable of seeing them as one target. To compound such problems later (more recent) sensor information may show that an assumed target correlation (in which two apparently different targets were assumed to be one and the same) in future DDF decisions needs to be de-correlated and de-aggregated based upon the new information. Hence prior history on sensings on that target must be retained and incorporated ASREQ. This solicitation seeks improved methods of M&S in the field of dense-target data fusion to facilitate answering the above and related questions.

It is evident that higher levels of data fusion are subjective and will benefit from an analytic framework that extends to structured argumentation for a decision process workflow with non-parametric criteria, and is clearly beyond the simpler topic of data integration. Specifically, the desired framework needs to characterize uncertainty of a decision space based on sensitivity, intelligence accuracy, conflict and ambiguity. Sensitivity can be expressed as the difference in results based on input tolerance.

In a dense target DDF scenario, processors are assumed saturated so that potentially significant and defining data may not be fused for consideration in the decision. It is the volume and ambiguity in available information that distinguishes a dense target DDF scenario. Thus, in the decision domain, one might examine a confusion matrix of alternative decisions and adjudication that considers discretionary factors. Conflicting data might be examined by

1) clustering of observations and mitigation by weighting by historical context,
2) experience bias and learning curve
3) advanced fusion techniques such as Bayesian analysis,
4) cluster analysis [6-7],
5) anomaly detection,
6) and graphic situational awareness (battle space characterization).

Effective disambiguation under conditions of multiple targets tracking in a sensor's field of view and multiple sensors' fields of view for a netted sensor grid are essential goals, since a dense target DDF decision process must accept numerous, diverse, ambiguous and conflicting sensor inputs from a variety of target objects and types of sensors reporting contacts. Probabilities of correct identification may be assigned, although a higher fidelity model would construct probabilities based on raw sensor input.

Government Furnished Information (GFI) will be made available to facilitate execution of the M&S. GFI may include raw sensor traffic from a communications model (as an example scenario traffic generator) in which asset nodes, topology and lines of communications are defined. Background sources may be defined under a given environment and also modeled by a communications model. The GFI will aid in representing ground truth with geospatial relationships as well as the confusion for the DDF scenario. Ambiguous and conflicting inputs from typical ISR sources may also be provided as GFI.

This solicitation asks for new concepts to enable analysis of the impact of netted sensors to achieve optimal DDF results. Flexibility of approach by bidders is expected and encouraged, as no single solution to Dense Target DDF is as of this writing apparent to the TPOCs, and a novel solution may be the best one. A successful outcome of this solicitation will be improved acquisition capability gleaned from mission-level simulators and their in- or off-line DDF engines, in the areas of improved sensor design, more effective targeting, and more effective Information Operations (IO) training under scenarios of densely-packed targets of unknown affiliation/allegiance. IO is referenced herein because of its heavy reliance on effective DDF for IO COA determination. The solicitation applies to Naval problems in Maritime Domain Awareness (MDA) and Maritime Interdiction Operations (MIO). This effort is expected to fundamentally enhance the state of Modeling and Simulation of campaign outcome based on red/blue decision strategy.

PHASE I: Define and develop concepts for improved dense target DDF characterization, leading to an improved common tactical picture (CTP) among surveillance platforms and one or possibly more distributed fusion centers and command facilities, with the ultimate goal of M&S of these concepts. Concepts must address battle space characterization as a factor in target resolution. The concepts shall explore CTP in light of adversary action and shall provide a data model representation of asset topology, sensor product, decision process and exacerbating factors. The simplest M&S techniques showing the largest potential improvement in clear COAs (hence the largest Return on Investment (ROI)) under such situations will be preferred, as run-time of the simulator will almost certainly be impacted. Agent-Based Modeling (ABM) methods and data fusion engines running alongside mission-level simulators must be considered, since such an architecture may be best suited for the stringent needs of IO and related training.

PHASE II: Develop, test and demonstrate a pilot representation of the proposed improved data fusion system running with mission-level simulators and possibly with ABMs. Show how disambiguation and COA capability under densely-packed target scenarios is improved, leading to improved M&S, acquisition and more effective IO training. GFI as sample data will be provided to aid in a prototype demonstration. A prototype demonstration in a contractor environment is sought by the Government as the exit criterion for this Phase.

PHASE III: Develop an improved distributed data fusion and tracking capability to work with mission-level simulators for operational test and Analysis of Alternatives (AOA). The research should be directed at applications in IO personnel training, as well as at general DON acquisition. Phase III will exit with a full-scale DDF scenario integrating live data feeds in a Military Operations Center (MOC) environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting product will provide a valuable surveillance data fusion capability for private defense industry and other private sector companies with applications involving distributed sensors with diverse detection characteristics and IO training. This capability will be an enabling technology in valuable products for private industry to sell to Government and other organizations dealing with human perception, human decision-making, and improved data fusion (c.f., [4]).

REFERENCES:
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2. Klein, Lawrence A., Sensor and Data Fusion: A tool for Information Assessment and Decision Making, SPIE Press, July 2004

3. http://www.nurc.nato.int/news/MSA-2009.pdf

4. http://www.data-fusion.org/article.php?sid=75

5. http://www.fas.org/man/dod-101/sys/ship/weaps/cec.htm

6. http://en.wikipedia.org/wiki/Data_clustering

7. Stone, L.D., et al, Bayesian Multiple Target Tracking, Artech House, Boston, 1999.

KEYWORDS: Data fusion; modeling & simulation; sensors; detection; information systems; command and control, Course Of Action (COA) tools

N101-102 TITLE: Adaptive System Behavior through Dynamic Data Modeling and Auto-Generated User Interface

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Mobile User Objective System (MUOS)

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted." The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop an innovative tool that incorporates dynamically updating net-centric data stores and auto-generating user interfaces to allow users to tailor their decision support environments in a timely manner.

DESCRIPTION: This topic addresses the operational problem of dynamically updating net-centric data stores and auto-generating user interfaces with minimum or no downtime with a focus on threat information against our critical 24x7 satellite communications operations. This dual-use effort will invoke services or capabilities to dynamically reconfigure data stores and user interfaces based both on the data integrated as well as learned user preferences allowing users to tailor their decision support environments in a timely manner.

Software applications are developed to analyze large data stores to solve specific problems. With the rapid expansion of data sources, static databases that are not rapidly extensible cannot support the data needs of threat warning, command and control, or other enterprise-wide commercial services. Also, an enterprise’s view of a problem domain changes over time. Software applications quickly become irrelevant without significant outlays for upgrades to adapt to changes.

The capability to dynamically update military and commercial enterprise applications in support of enterprise application integration would greatly increase responsiveness to growth in data sources and integration amongst systems. Example commercial data bases that can use this technology include transportation, healthcare, financial, education and insurance industries, amongst others. The challenge is to construct an adaptive user interface based on an ever-updating data structure to give the user a more personalized experience.

The area of intelligent and adaptive user interfaces has been of interest to the research community for a long time; however, to date research in this field has not led to widespread application. The emergence of dynamic data models, ontologies, and probabilistic network technologies offer the potential for finding an innovative enterprise solution to manage dynamic data stores and adaptive user interfaces. The proposed capability will allow more rapid access to constantly evolving and emerging information sources, which is applicable in fast-paced military and business environments.

PHASE I: Design an architecture around the concept for dynamic data model implementation and adaptive user interfaces. The architecture with dual use capabilities will be developed to support integration and interoperability with existing Navy Commercial-off-the-shelf (COTS) / Government-off-the-shelf (GOTS) technologies. This will be the basis for a Phase II prototype and demonstration effort.

Tasks under this phase could include:
• Design an architecture for dynamic data model implementation and adaptive user interfaces
• Identify technology shortfalls to be further addressed in Phase II

PHASE II: Based upon the proposed dynamic data management architecture and tools for adaptive user interfaces, a reconfigurable, extensible and adaptive prototype will be implemented and demonstrated in a laboratory environment. The Laboratory environment should include candidate systems to support a representative Navy operational environment consistent with the Four Layer Defense for SATCOM

• Implement a prototype
• In a laboratory environment, evaluate measured performance characteristics versus expectations and make design/process adjustments as necessary.
• Metrics of interest during the demo include:
o The latency between 1) the addition of a new data element to the data model and 2) that new data element appearing in the application editor UI.
o The latency between 1) a user's interaction with the system and 2) the effects of that interaction being interpreted and resulting in a semantically-driven change to the application editor UI (i.e. a new wizard is generated to facilitate that particular task in the future).
o The quality of the analytics engine, as measured by 1) the number of tasks that are successfully completed based on the auto-generated wizards relative to 2) the number of tasks that have to be performed the "hard way" by explicitly hunting down and changing data.

PHASE III: This phase will focus on migrating the laboratory demonstration to an operational capability required for defense of DoD satellite systems. Phase III will also have the goal to commercialize a reconfigurable, extensible and adaptive data model capability, algorithms and technologies within an enterprise framework relevant to other markets such as transportation, healthcare, financial, education and insurance, amongst others.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology can be applied to supporting the defense of any space system. Additional private sector commercial applications include transportation, healthcare, financial, education and insurance industries, amongst others.

REFERENCES:
1. User Modeling in Adaptive Interfaces
http://scholar.google.com/scholar?hl=en&q=author:%22Langley%22+intitle:%22User+modeling+in+adaptive+interfaces%22+&um=1&ie=UTF-8&oi=scholarr

2. OMG Model Driven Architecture http://www.omg.org/mda/

3. http://adenu.ia.uned.es/adaptaplan/pub/informeTIN2007.pdf

4. Microsoft Corp. (2005) "Adaptive Systems and Interaction", http://research.microsoft.com/adapt/

5. http://st-www.cs.uiuc.edu/users/johnson/papers/dom/DynamicObjectModel.pdf

6. Current Trends in Adaptive User Interfaces: Challenges and Applications
http://www2.computer.org/portal/web/csdl/doi/10.1109/CERMA.2007.42

KEYWORDS: Adaptive systems, dynamic data models, machine learning, services, architectures, probabilistic networks, adaptive user interfaces

N101-103 TITLE: Navy ERP Advanced Visual Reporting

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PEO-EIS Navy Enterprise Resource Planning (ERP), ACAT I AM

OBJECTIVE: To develop a software toolkit to describe, define and create spatial data models that can be can be dynamically linked into a framework to facilitate more rapid understanding of complex data sets for leadership decision making. This capability will allow users to spatially visualize complex situations and conditions and to retrieve associated data sets via a comprehensive user interface. The toolkit should contain the collection of standard shapes that can be arranged to compose the user interface. The toolkit can contain qualitative shapes that serve as navigational metaphors, as well as other linkages to quantitative data sets. It is the combination of standard qualitative metaphors integrated with standard quantitative data presentations, used to reduce complexity that is at the heart of this project. Based on Edward Tufte's research on Sparklines from "Beautiful Evidence" Yale, Published 2004 – this toolkit will have an innovative collection of sparkline like shapes and metaphors that will be used tested across multiple large organization systems and "systems of systems." This effort will explore effective new spatial data visualization methods, collaborative communication tools and an intuitive administrative back-end authoring system.

The pilot will provide a set of data and visual taxonomies with the objective of being mapped into a new visual spatial framework that does not currently exist and has never been attempted. The hypothesis is that a piece of middleware can be created that assigns shapes to data, enabling the merger of qualitative data (metaphor based shapes arranged for use as a taxonomy) and quantitative data (pulled from a variety of databases) in order to reduce complex amounts of data to intelligible systems.

This spatial framework will be accessible to multiple users in a multi-touch screen environment or other high definition, network enabled medium. The key elements of this system will be modeled and demonstrated in this environment, and analyzed for its impact on speed to understanding and quality of decision making for future growth to environments where thousands to tend of thousands of users simultaneously may access for their own decisions. This capability will enable users of existing Visual Information Maps (VIMs) at all levels to dynamically link and retrieve spatial data artifacts for the VIM region of interest to facilitate communications and decision making. This new capability or tool will be referred to as the Spatial Framework Mapping System. A key element of the effort will be to 'drill' down into datasets via the software toolkit for deeper understanding at level not achieved before.

DESCRIPTION: The objective of this research is to create and demonstrate the power of new spatial frameworks to improve decision making in complex environments. Current research on how the brain works to process information supports the premise that spatial visualization promotes faster and higher quality understanding of the data or information being reviewed. [See ref. citation] In many complex situations (intelligence operations for example) massive levels of information are being collected. This is driving the need to create new models and methods to represent data and information to accelerate groups of people in understanding this input, navigating through it, and in improving decision making from that understanding. The creation and demonstration of spatial frameworks to address actual situations and to enable data immersion is the focus of this research. [See ref. citation]

The research will extend the understanding of how different visual models work for different data sets to impact a user's understanding and comprehension. The integration of the visual data artifacts into the spatial frameworks will also be examined. The research will incorporate the use of Visual Information Maps for dynamic analysis, communication, collaboration and decision making. VIMs are increasingly being used to represent complex entities, including large scale systems, organizations, processes, solutions, products and other elements. These VIMs are spawning new vocabularies and facilitating more effective communications and understanding of the elements they represent. By combining this use of spatial visualization with the proposed new frameworks, a realistic capability can be created to dynamically link to and display underlying spatial data artifacts in unique and powerful ways within the framework to facilitate evaluation and analysis of a problem, set of options or other management challenge. This capability will require the development of data type definitions, display options related to data type, and administrative instruction sets to make the tool usable. A full integration architecture must be devised to establish the linkage modes and controls. This full concept development will establish the underpinnings of this effort to support the exploration of the most effective framework designs, spatial data artifacts and presentation modes. The results will provide the guidance for creation of the Spatial Framework Mapping System for deployments in a variety of settings.

The capability could be housed in a multi-touch screen environment or other high resolution, networked environment. The Microsoft Surface is one example of the many industry offerings that could be used to demonstrate this development. The resulting demonstration will illustrate a more effective and efficient way of analyzing data within the context of a spatial framework through tactile commands on the multi-touch screen. The underlying capability to link to and retrieve spatial data artifacts will allow data to be compared and evaluated or contrasted quickly. This will enable the user to evaluate different options and combinations of information in unique and powerful ways. The tool will be developed to accommodate communication and collaboration both in a physical space (fixed and mobile), and across an enterprise data network to allow users to collaborate across the hallway or around the world.

Situation or status reporting, data access, clarity of understanding and faster decision support for leaders are key areas of interest for managers in many environments, including DoD, Federal Agencies, Commercial and other enterprises. Custom reports for complex situations typically involve large costs, extensive time delays and steep learning curves. Visual Information Maps have materially improved the ability of leaders to represent these complexities in ways that improve the understanding and communications involved, but there is a compelling need to provide the next generation of capability to enable full data immersion using spatial frameworks to serve the leaders' requirements. By building this system capability on an enterprise level environment, the tool will be able to be adapted to a wide variety of situations and organizations. Because of the flexible data structures and the extensive visual spatial character of the presentation modes, the tool can be configured to aid in the management and operation of complex organizations, such as a global product distribution network, a complex supply chain implementation, a large scale hospital facility, an international manufacturing operation, or other situations that deals with complexity.

PHASE I: Create the definition and design for spatial data artifacts for a selected set of data sources. These definitions should incorporate inputs on different impacts of the design elements on speed and quality of user understanding of the situation being represented. How the user achieves data immersion, interactions enabled, collaboration factors, and other influences will also be examined. Tasks will include:
• Create a taxonomy and associated definitions for the data types and representation modes for underlying spatial data artifacts to be associated with different data sets or input sources
• Create a functional specification and architecture for the spatial framework software toolkit. The toolkit concept will be built on a limited amount of shapes/metaphors and then extended over time. The toolkit will also address the ability to link the shapes into specific Navy data sources
• Conduct exercises to examine the impact of various representations and combinations to determine the principals to guide the construction of the spatial frameworks
• Create the linkage modes to associate the spatial data artifacts with the spatial framework and the protocols for enacting the linkage, retrieval and presentation of the artifacts
• Design an instruction set for the user to dynamically interact with the spatial framework
• Establish the authoring and administration system for creating and maintaining the above elements
• Develop scenarios to examine the effectiveness of the spatial framework on the user time to understanding and the impact on quality of decision making

PHASE II: Create a demonstration model of the Spatial Framework Mapping System on a multi-touch screen platform. This demonstration is not expected to include all functionality for an enterprise wide implementation, but the design will describe how that functionality will be implemented as a subsequent phase to support enterprise level collaboration and communications. Tasks in this Phase include the following:
• Select a multi-touch screen platform for the demonstration
• Design a scenario developed in Phase I to demonstrate the capabilities of the Spatial Framework Mapping System and establish all of the necessary underlying spatial data artifacts. This scenario should support multiple users in a conference room setting to explore the information, ask questions, and gain decision supporting insights in an interactive group setting. The demonstration will show the power of the data immersion quality of the tool.
• Perform the demonstration as requested and evaluate the results, reactions, and observations

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL USE APPLICATIONS: The Spatial Framework Mapping System has extensive application in all DoD elements, all Agencies of the Federal Government, and all commercial businesses and enterprises that deal with complexity in the execution of their mission or business objective. This capability will be a powerful tool in strategic planning, training, decision making and many other uses.

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KEYWORDS: Visual; Reporting; Asset; Visibility; Financial; Decision-making

N101-104 TITLE: Co-Site Interference Mitigation in Phased Arrays

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PEO C4I PMW770 - Advanced High Data Rate Antenna and NAVSEA PMS435 - BLQ-10

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OBJECTIVE: To develop method(s) to address the effects and impacts of co-site interference with respect to phased array technology at X-band where transmit and receive bands are close in frequency.

DESCRIPTION: The limited space in the submarine sail requires the co-location of phased array apertures in a single antenna housing structure to provide capabilities in the desired frequencies of interest. Phased array technology is currently being investigated to provide wideband receive X-K band capability in one aperture with various narrowband transmit phased array apertures for X, Ka and Q-band transmit capability. Of particular concern is the communications degradation resulting from in-band transmit signals impacting the wideband receive array performance. GFI will be provided for approximate physical area allocated for various apertures.

The expected performance degradation will be the result of the transmitting in-band signal being received by the wideband receive array. The following are particular concerns with respect to the transmit signal: 1) Create a large signal very close to the intended SHF downlink channel degrading the G/T in the downlink receive band if there's transmitter noise at the downlink frequency - even if the LNA is not saturated. 2) Create significant harmonics that will eliminate utility at those frequencies for any other functions - even if the LNA is not saturated. 3) Saturate the LNA in most of the array elements - blinding the array for all downlink functions. 4) Damage the circuits in the receive elements.

Potential methods to investigate include, but are not limited to the following: 1) Component design such as high output power LNA stages to provide a larger spurious free dynamic range 2) Physical separation of the transmit array from the receive array as much as possible 3) Design techniques on the structure between the XMIT and RCV arrays that will reduce surface currents propagating between the two (RAM, resonant choke structures, frequency selective surfaces) 4) Separate radomes for XMIT and RCV arrays addressing reflected energy off adjacent radomes back into the receive array 5) Design rejection filters into the RCV elements before the LNA (will cause Noise Figure degradation) 6) Use Frequency Selective Surfaces (FSS) in front of the array to reduce incident energy at XMIT frequency 7) Attempt phase cancellation of interfering signal 8) Design all power and control signals to have significant rejection of the SHF uplink frequencies so that interference doesn't enter the array chain from the power supply and control lines. 9) Physical gating (choke structures) between the arrays.

PHASE I: Conduct modeling and analysis to determine the ability of the method(s) proposed for mitigating co-site interference to address the problem. A full analytical and if possible initial prototype assessment should be summarized and presented by the completion of Phase I to assess the effectiveness and likelihood of the proposed methods to allow full duplex communications of Narrowband X-band transmit operating with Wideband X-K band receive given the physical/spatial constraints.

PHASE II: Fabricate a proto-type system and test in a relevant environment the effectiveness of the developed method(s) in mitigating co-site interference with full duplex communications. Provide all modeling and test data to the Navy in a final report.

PHASE III: Partner with phased array equipment manufacturer to seek commercialization of the developed method(s). Method(s) should be ruggedized and capable of suitable operations in environmental conditions including shock and vibration related to the submarine environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Other potential applications include other branches of DOD (Army and Air Force) phased array applications, and commercial communications applications that are space limited and require arrays to be deployed in proximity to each other.

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2. "Wideband RF photonic pre-selector for dynamic co-site interference mitigation"; Borbath, Michael; Middleton, Charles; Wyatt, Jeffrey; DeSalvo, Richard; Avionics, Fiber-Optics and Photonics Technology Conference, 2008 IEEE.

3. SBIR Topic 101-104 Antenna Description, 8 pages

KEYWORDS: co-site interference; submarine communications; phased arrays; x-band transmit; x-band receive; high data rate

N101-105 TITLE: High Performance UHF Antenna for Nano-satellites

TECHNOLOGY AREAS: Electronics, Space Platforms

ACQUISITION PROGRAM: Mobile User Objective System (MUOS)

OBJECTIVE: Develop a high performance UHF antenna for use in nano-satellites.

DESCRIPTION: Nano-satellites are popular among universities and gaining momentum with commercial and government organizations. Standards based satellite buses and deployment mechanisms, such as the CubeSat and Poly Pico-satellite Orbital Deployer (P-POD), have stimulated growth in the area. Small satellites have proven capable and cost effective in many areas traditionally dominated by large satellites, however many challenges remain.

To date nano-satellites have primarily used relatively limited communications packages using amateur radio bands. The UHF band provides relatively low link loss and thus requires less power than higher frequency systems. However, lower frequencies have a greater wavelength, generally requiring larger, more massive antennas.

New research is needed to improve the capability of nano-satellite antennas. Current quarter-wave, dual-dipole, steel-tape UHF antennas provide approximately 5 dB of gain at the 70cm amateur band. A next generation antenna should provide significantly increased gain over a wide range of operational frequencies. The goal is to provide at least 11 dB gain over 280 MHz to 400MHz.

One important consideration in developing a new nano-satellite antenna is mission life. Many nano-satellites are deployed in Low Earth Orbit (LEO) where atmospheric drag is considerable. Since most nano-satellites do not carry propellant for station keeping, atmospheric drag is often a mission life limiting factor. The antenna's impact on mission life must be weighed in the design process.

A high performance UHF antenna will enable nano-satellites to expand from university experiments to operational missions. The antenna must meet the CubeSat Design Specification. Designs that fit in the 1U form factor are desired, however larger designs that provide significantly increased capability within the 3U form factor will be considered.

PHASE I: Develop an innovative UHF antenna design for CubeSats.

Tasks under this phase could include:
• Develop a UHF antenna design
• Predict system performance using modeling and simulation or other tools
• Estimate mass and volume requirements
• Estimate the design's impact on atmospheric drag

PHASE II: Build a prototype antenna and test it in the space environment.

• Optimize the antenna design
• Demonstrate operation of the prototype in a space environment such as thermal vacuum.
• Evaluate measured performance characteristics versus expectations and make design/process adjustments as necessary.

PHASE III: This phase will focus on integrating the UHF antenna into potential military CubeSat missions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology can be applied to a variety of commercial, military and space exploration nano-satellite missions.

REFERENCES:
1. CubeSat Design Specification REV. 11, http://cubesat.calpoly.edu/

2. M. Tamamoto, "Active Antennas and UHF Antennas for CubeSat Applications"

3. D. Ichikawa, "CubeSat-to-Ground Communication and Mobile Modular Ground-Station Development"

KEYWORDS: Nano Satellites, UHF antenna